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HOT DRY ROCK FEASIBILITY STUDY

August 1981

Work Performed Under Contract No. FG04-80ET27464

Plains Electric Generation and Transmission Cooperative, Inc.
Albuquerque, New Mexico

U. S. DEPARTMENT OF ENERGY
Geothermal Energy

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Prepared for the
U.S. Department of Energy
Division of Geothermal Energy
Washington, D.C. 20545

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SUMMARY AND CONCLUSIONS

Hot Dry Rock (HDR) is a newly anticipated source of heat energy presently being tested at the Fenton Hill site by the Los Alamos National Laboratory (LANL). The concept is simple. Drill access wells deep into hot granite, fracture the rock and recover the available heat by circulating water through the fracture.

Plains Electric Generation and Transmission Cooperative, Inc. (Plains), is evaluating the HDR concept to determine the institutional, legislative, and regulatory issues and problems which would have to be dealt with if a utility were interested in developing the resource for the commercial production of electricity.

GENERAL FINDINGS

In many cases, factual information is missing and research and development must take place if proven information is to be utilized to draw conclusions. However, given a rigid set of assumptions, the HDR resource could produce 10MW of base load electricity. An electric utility could expect, from assumptions made, the production of 600°F heat for a period of 15 years. It is estimated that another 15 years of operation could be attained by refracturing the reservoir. Generation of 10MW could be produced with a steam system utilizing dry cooling towers. Costs of equipment and disadvantages of organic fluids have ruled out use of a binary system.

It is anticipated that the reservoir and generating system will utilize 59 acre feet of water per year if assumptions are correct. This amount should be presently available from the existing developed well tapping the Abiquiu Tuff Aquifer. The 59 acre feet may tax the water

producing capability of the aquifer and it is therefore advisable to explore development of an alternate water supply. This alternative could be the limestone aquifers just below the Abiquiu Tuff.

To move electric power produced at the Fenton Hill site to points of utilization, nine transmission alternatives were examined. The favored alternative is a 69KV transmission line from Fenton Hill west to the proposed La Ventana Substation of the Jemez Mountains Electric Cooperative. This substation is planned for 1982 or 1983, and there appears to be no insurmountable construction or environmental problems anticipated at the time of this writing.

Environmental impacts of the potential generating facility should be minimal. There have been no recorded surface seismic events caused by research operations during the 7 years of the project. Other environmental factors have been studied and measured. The social and economic impacts are expected to be minimal because of the small size of the project. If commercial development of the resource takes place, then environmental analysis and monitoring should be continued.

Government, community, and institutional factors are complex. Cutbacks in the federal budget could have potential repercussions on the leasing and permitting process of HDR. State and federal government roles in a potential project should be positive, but that of local governments may not be as supportive. Most local governments were found to take no position on the development of HDR. The environmental and Indian communities oppose any geothermal development within the Jemez Mountains. Their major concerns are water, overall development, and religious significance of the Jemez Mountains. Chances are excellent that there are no areas of religious significance in the vicinity of the HDR site which would impact its

viability. It will be necessary to monitor three current, related legal issues concerning Indian religion and water use. The religious issues are involved, in part, in a request for an injunction against DOE's involvement in the Baca geothermal project being developed nearby, and the pending New Mexico Public Service Commission's (NMPSC) ruling on Public Service Company of New Mexico's (PNM) Certificate of Public Convenience and Necessity. The third legal proceeding is the Indian appeal of the State Engineer's ruling on retirement of irrigation water rights along the Jemez River. None of the obstacles identified will necessarily rule out the potential development of an HDR facility at this time, but they could severely complicate the process of project development and must be addressed.

Leasing of the geothermal resources, surface area, and acquisition of surface and subsurface facilities appear to be as complex as the institutional factors. Because of the complexities and inconsistencies in the federal government's leasing process, perhaps the most practical approach to leasing and the transfer of HDR facilities for the commercial development of power may be through special legislation passed by Congress. Such legislation could be designed to resolve several concerns that have been isolated and that impact HDR commercial development.

Regulations, permits, and laws do not seem to pose major obstacles. Local governments have no present regulations affecting HDR development. State government requirements do not appear to offer serious problems (as permitting processes go). Water rights acquisition may be contested by the Indian community, but it is difficult at this point to determine the magnitude of the problem. Permitting processes of the federal government will apply with the exception of the U.S. Geological Survey (USGS). There are at least six planning and engineering documents that must be completed

prior to the operation of any geothermal facility. These documents should cause no major difficulty, but will require a great deal of time and study.

Financing is uncertain due to the irregularities of interest rates and continuing inflation. Under the existing circumstances, no reasonable long term projections can be made. It is, therefore, necessary to consider the existing circumstances which follow: Rural Electrification Administration (REA) will fund alternate energy sources such as HDR. Therefore, the Federal Financing Bank loan guarantee program with its built-in flexibility should be utilized during the first seven years of the loan period. For the commercial development of electricity, by those outside of REA funding, financing would be made through conventional methods and would be subject to existing interest rates.

SPECIAL ISSUES

A number of special issues require attention in any effort by the government or industry to commercially develop the Fenton Hill HDR resource. The following deals with those issues:

Underground Reservoir

A large number of assumptions were made with respect to the reservoir system and have to be verified to assure continued production of heat over a 30 year period. Questions still to be answered are as follows:

1. What will be the actual amount of water required to Initially fill the commercial reservoir? The current assumption is 5 million gallons or 15.3 acre feet. Other estimates go as high as 20 million gallons or 61.4 acre feet. A difference of 400 percent is extremely significant when contrasted to water availability and on-site storage capacity.

2. At the present time one fracture is estimated to have a 15 year life expectancy at temperatures of 600°F. Determinations must be made regarding multiple or single fractures and the economics of each. Multiple fractures carried out vertically may require only two bore holes, but would require casing and sealing to separate one from another. Vertical fractures would also require deeper drilling.
3. Water loss while circulating through the reservoir needs to be determined as precisely as possible. Presently water loss is estimated as a percent of average flow through the generating system. This number may range from 1.5 percent to 6 percent. Actual water loss will depend on size, porosity of reservoir medium, continuation of thermal fracturing, accumulation of precipitates, and other considerations. The rate of water loss may be unique to each reservoir, but the amount must be established in order to build a sound water use estimate.

Generation

There appear to be no major issues regarding the above ground generating facilities.

Water Resources

The following water issues should be given consideration:

1. If commercial application of the HDR requires 59 acre feet of water annually, the readily available Abiquiu Tuff aquifer will be taxed. There will be no room to accommodate additional requirements of the project.

2. There are several water options that should be explored to meet additional demands. Those include: re-think design of generation system, or re-explore the binary system in terms of water efficiency and cost. Carry out the necessary studies and testing to determine the capability of the limestone aquifer below the Abiquiu Tuff. Explore the cost of water purchase and hauling in amounts necessary to provide sufficient back-up to the Abiquiu Tuff.

Transmission

There appear to be no major impediments attributed to the transmission of power generated at Fenton Hill.

Environment

There appear to be no major impediments attributed to the environmental aspects of commercial development of, or transmission of power from, Fenton Hill.

Government and Community

A number of issues have surfaced in the government and community sectors. They are as follows:

1. Federal budget cuts may affect permit and leasing time frames and create longer lead times.
2. Utilization of the Abiquiu Tuff aquifer could be beneficial in offsetting any major opposition to utilization of interconnected aquifers or surface waters.

3. Environmentalist and Indian concerns about development in the Jemez Mountains could potentially be offset by a program designed to limit the number of megawatts produced in the Jemez Mountain area.
4. If pending legal actions regarding religious freedom are settled in favor of the Indian community, then Fenton Hill development could be extremely difficult.

Leasing

Potential constraints and questions which have been identified in the review of the procedures for acquisition of the use of the HDR Project geothermal resources, surface area and facilities include:

1. The HDR Project site includes both Known Geothermal Resource Area (KGRA) and non-KGRA lands. The different leasing procedures required to acquire a lease for these lands - competitive bid for KGRA lands and non-competitive application for non-KGRA lands - could preclude a single utility or entity from acquiring the lease of the entire HDR Project area necessary to demonstrate the HDR resource.
2. The individual lease acreage limitation under the Geothermal Steam Act of 1970 of 2,560 acres is less than the size of the current HDR site. This statutory limitation could preclude the lease of the entire geothermal resources developed at that site for the commercial demonstration.

3. Conflicting records of the Bureau of Land Management (BLM) have raised the question whether the geothermal resources available to the HDR Project are owned by the United States and available for lease under the Geothermal Steam Act of 1970.
4. The present leasing availability of the HDR Project site is unclear. Although requests have been made to the Bureau of Land Management not to lease these lands until the project is completed, BLM records, with respect to certain of the HDR Project lands, do not reflect any present prohibition against leasing.
5. The U.S. Forest Service (USFS) has consent authority over any geothermal lease of the HDR Project area. The HDR Project is in a USFS designated no-lease area, to be excepted from geothermal leasing under current USFS policy and practice.
6. The current Agreement governing the Department of Energy's (DOE) use of the HDR Project site specifically prohibits the commercial development or generation of electricity. The proposed power plant reviewed in this study would not be possible under this Agreement.
7. Certain language inconsistencies in the Geothermal Steam Act of 1970 and regulations promulgated thereunder create confusion over the application of the Act's requirements.
8. The absence of a single method or procedure by which the entire HDR Project geothermal resources, site and facilities could be acquired makes the acquisition by a single utility or entity capable of demonstrating the resource an uncertainty.

Regulations, Permits, and Laws

There appear to be no major impediments attributable to the regulation and permit process.

Financial Considerations

The major financial issues are as follows:

1. Available financing methods, as to interest rates, are too uncertain to allow long term projections.
2. If interest rates are expected to decline on the long term, then a lender with a variable rate would be the prudent choice. If rates appear to hold steady for the long term, then REA's or DOE's guaranteed loan programs may be the prudent choice.

Conclusion and Recommendations

The HDR study was divided into ten major sections. Six of those sections indicate uncertainties as to the feasibility of commercial development of HDR:

Reservoir	Feasible with rigid assumptions - uncertainties
Generation	Feasible
Water	Uncertainties
Transmission	Feasible
Environment	Feasible
Community	Uncertainties
Leasing	Uncertainties
Permits	Feasible
Finances	Uncertainties (but feasible)
Cost	Uncertainties

HDR could be a viable source of heat energy to produce electric power. If a rigid set of assumptions can be met, HDR can be viable. In reality, it is not known whether the assumptions made for this report will hold.

Several years of additional LANL technical research are planned for Hot Dry Rock. During those years, answers to the above assumptions will become clearer. All options should be held open regarding commercial application of this resource. Detailed technical research should be monitored to obtain answers to current uncertainties. The community and institutional issues should be monitored for their potential resolution. Steps to resolve the permit and leasing requirements should be initiated where possible because of the long lead times involved. If variables and uncertainties are resolved in favor of HDR, then further steps should be taken to utilize the resource.

The HDR process should be evolutionary regarding commercial development. Take a few steps at a time, then evaluate the situation before moving to the next step.

INTRODUCTION

With the growth in demand for electricity, it is necessary to continuously add generating capacity and power reliability to electric systems. This additional power must be provided at the lowest possible rate consistent with sound business practice in order to hold down the cost to the ultimate consumers.

With this in mind, in August of 1979, Plains submitted a proposal to the DOE to examine the feasibility of electric power production from Hot Dry Rock at the Fenton Hill, New Mexico site. The following pages provide the results of that examination as well as an explanation of HDR and the background on Plains' involvement.

HOT DRY ROCK BACKGROUND

Until recently HDR energy has been an unavailable resource. Basically, HDR is the heat source available in the earth's crust within approximately 10 kilometers or 6.2 miles of the surface. Steam and hydrothermal geothermal systems have been commercially demonstrated in this country, but manmade HDR energy systems are just now being tested as a viable energy source.

Normal geothermal heat gradient (earth temperature) averages 30°C per kilometer throughout the world. There are variations where that gradient is significantly higher. These cases provide a potential for HDR energy, and such a spot is the Fenton Hill site near Los Alamos in the Jemez Mountains of New Mexico.

To tap heat bearing granite, scientists originally suggested that a hole should be drilled to the depth of required temperature output.

Fracturing of the granite by pumping in water under pressure could then be accomplished which would create a reservoir into which water could be circulated to pick up heat. A second hole would then be drilled to intersect the reservoir of fractured granite and the water could be pumped to the surface. Water would transport the heat to a generating or other facility and would then be recycled through the reservoir and maintained in a closed system. Such a closed circulating system has environmental advantages in that few emissions are made to the air, ground, and surface water environments.

In 1970, an HDR research project was established at LANL. The project goal was to demonstrate the feasibility of HDR technology. During the following years LANL drilled two access wells, created a reservoir, and by mid 1977 demonstrated, on a small scale, that the heat source could be withdrawn from the underlying granite. To accomplish this feat, scientists had to develop much of their own instrumentation with which to determine depth and direction of drilling as well as to map the reservoir being created.

Subsequent events included attachment of a small electric generating plant; the portable unit of 60-KVA provided approximately 12 percent of the site's electricity demand. The environmental impact of the HDR research project to produce electricity has been studied and those studies indicate a relatively impact-free facility. Perhaps the most significant outcome of this small demonstration project was the decision to move ahead to demonstrate the commercial application of HDR to produce electricity. DOE has initiated additional drilling to create a larger and deeper system and reservoir upon which to build a 4 to 10 MW commercial electric generating station.

PLAINS' INVOLVEMENT WITH HOT DRY ROCK

Early in 1979, Plains entered into discussions with DOE to become acquainted with the Fenton Hill HDR program and to express interest in potential commercial electric power generation at the site. Because DOE had precluded funding from their budget for construction of a 4 to 10 MW facility, it therefore invited interest from private industry.

On August 22, 1979, Plains submitted an unsolicited proposal to the U.S. Department of Energy, requesting grant funds to study the feasibility of commercial electric power generation at Fenton Hill. The proposal requested \$121,800 for Phase I studies over a 12 month period starting in October of 1979. The final Notice of Grant Award from the Department of Energy defined the study period from April 4, 1980 through March 31, 1981. The March 31, 1981 date was revised later to August 31, 1981. This document is the culmination of those studies.

Plains is interested in HDR for several reasons. As the all requirements power supplier to 13 rural distribution cooperatives, it is necessary to provide dependable and sufficient power and energy. Alternate energy resources such as HDR can increase power availability and, as an additional source, add dependability. It is also in the national interest to seek out alternate energy supplies to reduce the dependence on foreign oil and to increase energy options where economically feasible.

Economically it is in the consumers' best interest to be able to take advantage of the research and development investment already made by the United States Government.

Methodology

The overall project, as envisioned by Plains, if carried out, would include three phases. Phase I involves studies to determine community issues, engineering, institutional, environmental, legislative and regulatory constraints and requirements. Phase II, if implemented, would include detailed environmental analysis, economics, and facility design. Phase III, if implemented, would involve construction and operation if the previous phases so indicated. Some overlap would exist between these phases particularly I and II, wherein permits defined in Phase I would require a supporting Environmental Analysis to be developed in Phase II.

The Phase I studies included 10 tasks that are to provide preliminary information regarding the project's feasibility. These tasks were developed to point out the opportunities and problems which would be confronted if an effort is made to bring the project into reality.

The major task headings are as follows:

1. Government & Community Factors	6. Transmission
2. Regulations & Permits	7. Leasing
3. Environment	8. Water
4. Reservoir*	9. Financing
5. Generation	10. Economic Report

* Reservoir includes those studies related to the underground hot dry rock that must be fractured to create a reservoir through which water can be pumped and heated.

Purpose and Goals

Beyond the specific objectives and purposes of Phase I, there are other underlying general objectives. One is to determine, from the very beginning, if there is an acceptable approach to developing a HDR power generation project. To accomplish this, an attempt was made to involve the community and government (to the extent of their interest) at the beginning of the project in order to insure their understanding and, hopefully, gain their acceptance and approval. By working with the community and government, an effort was made to:

- a) Provide information about the project;
- b) Gain information on issues concerning the project;
- c) Assure that issues and concerns will be properly addressed; and
- d) Make arrangements to provide current information throughout the progress of the project.

The objective of Phase I was to identify and report the factors which have an impact on the commercial development of HDR energy. In several instances, information is lacking or assumptions made which have a direct bearing on the feasibility of developing HDR. It may take several years of testing and demonstration before all the missing technical facts are developed and assumptions are answered.

HOT DRY ROCK RESERVOIR

METHODOLOGY

The HDR concept is basically embodied in the reservoir, the heart of the system. The LANL, with technical assistance and funding provided by the DOE, created a prototype reservoir with which it demonstrated the feasibility of the HDR concept. Now LANL is creating a second reservoir which will, hopefully, be used to demonstrate commercial application of HDR. The intent of this section of the feasibility study is to evaluate LANL's past research with HDR, establish a set of assumptions pertinent to the reservoir, provide recommendations, and discuss pertinent conclusions.

If successfully completed, the reservoir currently under construction at the Fenton Hill site, will be fitted with a generating unit to produce up to 10MW of base load power. To produce this power economically, the fractured granite reservoir will have to yield heat for a period of 30 years.

A major point to keep in mind is that this is the first time this concept will be utilized on a commercial scale. Nearly all of the data produced has originated from LANL. The data includes design work, experience with the first set of test wells and fracture, and the reservoir presently under construction.

ASSUMPTIONS

To prepare this portion of the study, it has been necessary to make a number of important assumptions that have a substantial effect on this project. These assumptions will not necessarily have an effect on other subsequent projects at other sites. The assumptions are:

1) The developer will not have to pay for the land, existing equipment, wells, fracture system, or any previous or projected research and development work;

2) The reservoir system will be ready for use by the developer and will not require significant modification, repair, or expansion;

3) Bottom of the hole rock temperature will be a minimum of 600°F or 315°C;

4) Reservoir will be full of water, the amount of which will not exceed 5 million gallons;

5) Water loss through the reservoir will not exceed 1.5 percent of average flow or 37 acre feet annually; and

6) For each of the original and the second fracture systems, there is a 15 year useful life.

SYSTEM CHARACTERISTICS

The system as transferred to the developer by LANL will consist of two shafts, 15,000 feet deep, with a large interconnecting fracture system. The mechanics of producing the fracture system consists of:

1) Drilling the first 15,000 foot deep shaft down into unfaulted, stable basement granite;

2) Directionally drilling a second shaft to within several hundred feet of the bottom of the first shaft;

3) Producing a suitable sized fracture between the two shafts by hydraulic means; and

4) Mapping the shape, size, and orientation of the fracture.

This is a difficult operation to undertake and the risks involved are not inconsequential. Unfaulted, stable basement granite is much harder than

material usually encountered in the oil and gas industry. Drilling granite to significant depths requires the best available technology and technique. In addition, the high temperature environment encountered drastically affects life and operation of equipment. Special well monitoring and location tools were developed for this high temperature application.

Accurate directional drilling required development of sophisticated new techniques that far exceed any in common use. Sophisticated logging tools, and down hole mud powered drills have been developed.

The risks involved in the HDR operation are significant and unavoidable. However, drilling technology is mature enough so that the problems encountered so far have been solved. There is the risk that problems may be encountered with a particular well system that cannot be solved and this could force the abandonment of that particular well system.

All of the preceding items of discussion are major points in determining the cost of the system. As it appears from the history of the test wells, the development of holes to 15,000 feet would cost approximately \$15,000,000. The cost per KW could decrease rapidly as the size of the energy output increases. This is due to the potential for multiple fractures and other enhancement techniques that could be made from a single set of shafts.

The size of the fracture required to provide enough heat to operate a base loaded 10MW unit is about 2000 feet in diameter assuming a circular fracture and a rock temperature of 600°F.

Open area must be provided around the well heads to allow access and operation of a drilling rig. The open space is necessary to expand the system, or to conduct major repairs that necessitate redrilling.

If there is reason to bring in a drilling rig, it may be an opportune time to expand the capacity of the system by further fracturing or by producing a second fracture and thereby extending the life of the unit. If the first fracture is expected to provide 15 years of service, a second fracture should provide an additional 15 years of service or a total of 30 years for the system. The second fracture is estimated to cost \$2 or \$3 million in 1981 dollars.

SYSTEM OPERATING CHARACTERISTICS

The operating characteristics of the below ground system are quite simple and somewhat similar in many respects to that of a once-thru type steam generator. Water is pumped into the injection well, through the fracture where it is heated, and back up the production well and then to the power plant. The injection pressure would be sufficient to prevent flashing to steam until the 500°F water reaches the flash tank. See Figure 1.

The useful life of a 2000 foot diameter fracture is estimated to be about 15 years at a 10MW base loaded production rate. This is based on modeling carried out by LANL on 2800 hours of operation of the prototype system. At the end of the 15 year period, it will be necessary to determine the most appropriate course of action from the following alternatives:

- 1) Abandon the unit totally;
- 2) Abandon the well system and move to a new site;
- 3) Shut down the system for an extended period and allow the temperature in the formation to rise;
- 4) Enlarge the present fracture; or
- 5) Redrill and produce an additional parallel fracture or fractures.

A phenomenon experienced in the prototype test system could extend the useful life of the reservoir. This phenomenon, thermal stress cracking,

FIGURE 1
RESERVOIR SCHEMATIC

occurs as the cooler injection water induces stresses in the rock causing it to cleave and extend the size of the fracture. The extent of this process is not known at this time.

The present well heads and casings installed for the LANL prototype test series appear to be adequate from a design standpoint for generation. The actual condition should be verified by non-destructive testing before transfer of equipment or before major expenditures of money are made. These tests should not exceed a cost of \$100,000.

The long term loss of water to the formation is predicted to be about 1.5 percent of the average flow as observed during extended operation of the first prototype reservoir system. A trend was established showing the loss to be slowly declining with time as the rock around the fracture became saturated. With time the loss should reach a very small percentage of the flow water.

The average water flow at the injection well is estimated to be 1542 gpm. The 1.5 percent water loss is based on a 365 day year and amounts to 37 acre feet annually. See Figure 2. The reservoir loss will be dependent upon the porosity of the granite, the degree of thermal stress cracking, accumulation of precipitates, and others.

At this point there is uncertainty as to how much water will be required to fill the reservoir. The assumption at this time is 5 million gallons. It will be important to verify this number because the reservoir system must be drained to redrill and fracture at the end of the life of the first fracture. Accommodation is being made by LANL to store 5 million gallons on site. Original estimates by LANL ranged from 15 to 20 million gallons with a six percent make-up until the amount of water loss stabilized

**FIGURE 2
HDR WATER REQUIRMENTS**

SANITARY REQUIRMENTS
.62 GPM
1 acre foot/yr

TOTAL SYSTEM REQUIRMENTS
38.62 GPM or
59 acre feet

at 1.5 percent of average flow. With estimates that can vary by 400 percent in some cases, it will be important for the developer to seek more precise estimates of the water requirements.

The number of fractures required in the reservoir is also an uncertainty at this time. For purposes of this report, one fracture is being considered for each of two 15 year time periods. One early assumption by LANL was three fractures which could be made side by side with additional bore holes made to accommodate them, or they could be stacked vertically one on top of the other. In the latter case, each reservoir would need to be sealed while one of the others was being utilized to produce power. This issue will hopefully be resolved during current research by LANL.

It is necessary to emphasize the importance of the actual rate of water loss from the reservoir system. If the rate of loss at the initial filling is estimated to be 6 percent of flow, this could create a demand for approximately 150 acre feet per year. If this amount of water is needed for the second fracture, 15 years into the operation of the project, then water availability could be a problem.

Outgasing from the formation and the build up of scaling components from the make up water are predicted to be so low as not to require any special provisions for treatment and/or removal.

The wells and reservoir system will be left full of water after the conclusion of the LANL test series. This will result in a substantial savings in water and time for the ultimate developer.

CONCLUSIONS AND RECOMMENDATIONS

Given the above assumptions, the HDR Reservoir may be workable on a commercial basis. However, many technical refinements must be made in order to insure that there will be a viable source of energy. On the basis of

limited experience, a developer could assume that power can be produced by the HDR concept. The developer can expect that problems will occur in the future that will require ingenuity.

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GENERATION FACILITIES

METHODOLOGY

The overall approach to the HDR conceptual design should include considerations of viability, efficiency, and reliability. All these should be consistent with good utility design practices. The system should be base loaded. It should have an estimated 10 MW Net Capacity with a useful life of at least 30 years.

Current knowledge and experience of both steam and binary systems were reviewed as well as cost and availability of hardware. The selection of a reliable generation facility has been based on advantages and disadvantages of each. The assumption that the system should be approximately 10 MW net is based upon the following:

- a) it is essential to utilize the maximum thermal capacity to the maximum economic benefit.
- b) it is not difficult to scale up from 10 MW to larger units;
- c) dollars per kilowatt installed costs are probably too high for consideration below 10 MW; and
- d) equipment costs of the unit would not decline at the same rate as size is scaled down.

AVAILABLE GENERATING TECHNOLOGY

There are two basic concepts for the generation of electricity utilizing a heat source with the properties of the HDR system that would have potential commercial applicability. These are: a steam turbine utilizing vapor flashed from the saturated liquid output of the well, and a binary system in which an organic fluid is vaporized utilizing hot water from a well in a closed loop system.

The steam system has several advantages. It has an extensive operating history to draw from beginning in 1903 to the present. Unit sizes range from 0.3 MWe to 1300 MWe, and the systems operate on a wide range and quality of steam sources. Water is also stable and nontoxic in all perceivable temperature ranges and is generally readily available. The concentrations of dissolved minerals found in the water to be utilized by the HDR project are within the accepted metalurgical limits of available technology. Additional efficiency is gained with the steam system by the elimination of intermediate heat exchange equipment necessary to the binary concept. Contacts with major manufacturers show that 10 MW units are available within specification ranges required by a developer and they have the additional advantage of being skid mounted.

The disadvantages of steam are two. Only twenty percent of the water flow from the reservoir can be flashed while the remaining eighty percent is rejected and pumped back into the reservoir. Secondly, the capital and operating cost for water treatment will be higher for steam than for the binary system.

Upon examination of the binary system, the advantages are found to be outweighed by the disadvantages. One of the advantages is that the organic fluid, which picks heat up from the water in a heat exchanger and carries it to the turbine, is inert. This characteristic allows for a clean turbine and condenser system and causes no significant scaling or corrosion. A second advantage is the low boiling point of organic fluids. This advantage allows utilization of binary systems where resource temperatures are too low to use steam as the working fluid. The third advantage of the binary system is the compact turbine design. This is due to the high molecular weight of the

organic fluids. Such fluids have the capacity to carry a given amount of heat within a smaller volume of fluid as compared to steam.

The disadvantages of the binary system are as follows: The cost of installation is higher than for a comparable steam system. This is due to the additional equipment with this system and to higher production costs associated with a relatively new technology.

The binary system is roughly 40 percent more expensive than the steam system. The cost of organic fluids is also very high and ranges from three to four dollars per pound. Comparatively, demineralized water can be produced at about twenty-five cents (25¢) per ton. Organic fluids are only produced on demand, and this can lead to unacceptable lead times of several months in the procurement process. Those fluids also have environmental and personnel exposure problems which complicate their handling. Long term stability at elevated temperatures and flow applications is not well known, and this could lead to fluid decomposition under the stresses inherent in the HDR concept. The experience with organic working fluids in generation service is minimal. Extrapolation in design to larger machines may not be valid. The largest machine so far designed specifically for generation service is of 0.5 MW capacity and would require scaling up by a factor of 20 for application to this project. The only geothermal machine of this size operating on an organic fluid has been in service for less than one year and has exhibited serious equipment problems. Organic fluids have proven difficult to seal in equipment such as pumps and turbines.

After considering the advantages and disadvantages for both systems, it appears that a steam turbine system would be the most suitable for this application at this HDR site. Conversely, the binary system would be more

applicable to sites with lower resource temperatures or with higher levels of water contamination.

COOLING SYSTEM

In any thermal power generation process, large amounts of waste heat must be rejected to the environment. This normally amounts to about 75 percent of the energy inlet to the turbine. For sites away from large bodies of water, this heat must be dissipated to the atmosphere either by evaporation of condenser cooling water in a wet tower or by condensation of the exhaust steam in a dry tower with the heat being carried away by convection to ambient air.

A wet cooling tower utilizes the traditional concept of condensing steam in a condenser cooled with circulating water which in turn is cooled by evaporation of a portion of the flow in a wet tower. Water loss for this concept could run as high as 208 gallons per minute with an average rate of 105 gallons per minute. Mineral laden drift or mist from the tower could be an environmental problem.

The dry system ducts the exhaust steam up to a series of convective cooling coils where the steam is condensed inside of tubes cooled by ambient air forced across them. The water usage for this concept is essentially zero.

The capital cost of a dry cooling tower is much higher than its wet counterpart, but the trade-offs in the reduction of other equipment reduces the ratio to less than 2 to 1. The operating cost of a dry tower is also higher due to the higher fan power that is required.

There is a reduction in land usage by the dry system over a wet tower due to a reduction in space needed for blow down ponds. This is because the dry tower is built above the turbine house.

Due to the tenuous nature of water supplies in the project area at the time of this report, land availability for ponds, and environmental problems with mist, the dry concept should be selected as the wisest alternative at this point.

The projected water use for the steam system with dry tower cooling on the above ground portion of the unit is 15 gallons/minute. An additional 0.62 gallons per minute is projected for sanitary and miscellaneous uses for a total of 15.62 gallons per minute or 22 acre feet per year. This amount added to the reservoir loss equals 59 acre feet required per year. See Figure 2.

MECHANICS OF GENERATION

The workings of this generation process are best described by detailing the process through the flow pattern and by observing the schematic in Figure 3. The process is as follows:

1. Flash Tank

Receive water at 500°F & 700 PSIA from the production well into the flash tank.

Flash 20% (152,004 lbm/hr) to steam in a single flash process. Reject 80% (608,014 lbm/hr) as water. Flow = 1519 gallons/minute.

Reject water is cooled to 420°F.

2. Side Stream Clean-up System

2-3% of reject water is bled off, cooled to 100°F, processed in the side stream clean-up system and added to the hot well.

3-4. Turbine/Generator

Flashed steam at 326°F & 99 PSIA is expanded through the turbine and exhausted at 5.5 in HGA.

FIGURE 3
SYSTEM SCHEMATIC
ABOVE GROUND FACILITIES

5. Cooling Tower

Exhaust steam is condensed in the tubes of the dry condenser - heat is rejected to ambient air and drains to the hot well. The condensate temperature is about 120°F.

6. Deaerating Heater and Storage

The condensate pumps, both main and booster, pump from the hot well into the deaerating heater where the condensate is mixed with the reject water.

Feed water outlet from the de-aerating heater conditions

T = 350°F discharges to the feed pump section.

P = 300 PSIA

7. Feed Pumps

Feed water discharges to the injection wellhead

T = 350°F

P = 2100 PSIA

flow = 771592 lbm/hour or 1,542 gallons/minute

SPACE REQUIREMENTS

The space required to install this unit is estimated to be from 17 to 20 acres. This is using projected equipment sizing, optimum access for maintenance, and areas set aside for additional ponds. There are 17 acres available at the Fenton Hill site, but only 13.5 acres are currently fenced.

COST ESTIMATES

Cost estimates are based on current prices for similar equipment for conventional generating stations. Manufacturers estimates are used for unique equipment. Additional estimates were used for check figures. The cost estimates for individual pieces of equipment are as listed in Table 1.

TABLE 1

Cost Estimate

<u>Item</u>	<u>Estimate (x \$1000)</u>
1. Turbine/Generator	2750
2. Site preparation	390
3. Foundations	350
4. Structural Steel	165
5. Flash Tank	850
6. T/G Crane	45
7. Feed & Cond. Pumps	175
8. DA Heater	90
90. Transformers	126
10. Hi Press Pipe	175
11. Steel Valves	55
12. Cooling Tower	1276
13. Elect. Equipment	225
14. Air Compressor	90
15. Steel Tanks	190
16. Control Boards	130
17. Water Treating Equipment	380
18. Power House Structures	1050
19. Raw Water Pipeline	70
20. Yard Structures & Piping	345
21. Equipment Erection	345
22. Power Piping	1205
23. Power Wiring	520
24. Wells & Pumps	175
25. Painting	90
26. Paving & Landscaping	175
27. Wire & Cable	90
28. Water Plant Structures	175
29. Electrical Testing	35
30. Construction Testing	45
31. Subsurface Testing	35
32. Contingencies (14.5%)	1720
	<u>\$ 13,537</u>

Based on these estimates the capital cost of the above ground portion of the installation is \$13,537,000 or \$1,354/KW at 1981 prices.

PLANT CAPACITY FACTORS

Projections for plant capacity factors (annual plant operation reliability) are broken into three time periods. They are projected to be somewhat longer than is typical for conventional units due to the newness of this generation concept. The time periods and significant factors are as follows:

1st year	Full load operation after commercial acceptance
57%	of the unit is estimated at 5000 hours. Maintenance
Operational	and forced outages are estimated at 3760 hours, principally to make major equipment changes if necessary.
2nd - 4th years	Full load operations are estimated at 7000 hours.
80%	This allows for bi-annual three week outages for
Operational	inspections and additional time for forced outages.
Long term	Full load operation is estimated at 7500 + hours
85.6%	with one annual outage of 3 weeks duration plus
Operational	time for forced outages.

PLANT STAFFING

Plant staffing is projected to be 18 people working a five shift operating schedule as shown in the accompanying personnel chart, Figure 4. The annual cost estimate for these employees is approximately \$330,000.

FIGURE 4.
PERSONNEL CHART

TOTAL NUMBER = 18

CONCLUSIONS AND RECOMMENDATIONS

From a technical standpoint, the generation of electricity utilizing the HDR concept appears to be feasible. No insurmountable problems, from a generation standpoint, in applying this concept to other sites were found.

After a review of available generating technology, a steam turbine system appears most suitable for the Fenton Hill site. Additionally, because of the scarcity of water, a dry cooling system appears more advantageous than wet cooling towers. Water use for steam systems with dry cooling towers is concluded to be no more than 37 acre feet per year. Total water use at the site is estimated to be 59 acre feet per year. Space requirements are judged to be no more than the 17 acres currently available to DOE.

From a cost standpoint the unit would be expensive on a dollars per kilowatt basis. The projected \$1354/KW capital cost of the above ground installation is comparable to that of the entire capital cost of new coal fired generation. Yet, with the benefit of no fuel costs, the system appears to be economical, in this case, and feasible for a developer to investigate.

The economy of scale on a larger unit would improve the dollars per kilowatt figure. As unit capacity increases, the size and the cost of pieces of equipment do not rise at as great a rate. In addition, larger units can justify the use of more elaborate and efficient arrangements of equipment, but most probably require more surface area.

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WATER RESOURCES

METHODOLOGY

On December 12, 1981, Geohydrology Associates, Inc., was authorized by Plains to participate in the HDR feasibility study. Specifically, it was necessary to determine the quantity and quality of the available water, its sources, and the approximate costs of developing a water source for the HDR project.

A study of the area was made to determine the geologic conditions and to evaluate the accuracy of existing geologic maps. Hydrologic data were collected for wells in the area. Well logs and other historical data were obtained from files of LANL and from the office of the New Mexico State Engineer. Publications of the U.S. Geological Survey and LANL were reviewed, and interviews with various individuals were conducted.

This section presents a summary of the quantity and quality of both surface water and ground water resources in the area of the Fenton Hill site. The report also includes recommendations for obtaining additional ground water supplies by on-site drilling into deep aquifers. Cost estimates are presented for: (1) obtaining additional water from surface water sources; (2) drilling and construction of wells on-site for ground water supplies; and (3) availability of water rights.

AVAILABILITY OF WATER

Ground Water

Preliminary engineering studies by others show that the HDR facility proposed will require 59 acre feet of water per year. This volume of water use is equivalent to a continuous discharge of about 38.62 gpm (gallons

per minute). It is assumed that the reservoir system will be full at the time commercial operation begins.

A number of geologic and hydrologic studies have been conducted in north central New Mexico which includes the Fenton Hill site. The earliest studies (Hayden, 1873; Cope, 1877) were conducted as part of the regional exploration of the Southwest. Subsequently the mining potential in the southern Jemez Mountains was described by Graton (Lindgren and others, 1910). Detailed geologic mapping began prior to World War II, and this work was later published by Smith and others (1970). The most comprehensive hydrologic study was made by Griggs (1964), although this investigation did not extend as far west as Fenton Hill.

Ground water occurs in the Caldera fill in the Valles Caldera and in volcanic rocks and sediments adjacent to the Caldera. Water supply for the community of Jemez Springs and the Jemez Pueblo comes from springs and a well. Other water for domestic and recreational use is obtained from springs or from shallow wells in the alluvium along stream channels.

A number of test holes were drilled in the Valle Toledo and Valle Grande in 1949 to determine if a water supply could be developed for Los Alamos (Griggs, 1964, p. 80). Testing indicated a delicate balance between ground water and stream flow. Pumping wells in these areas would deplete stream flow and therefore the development of a water supply for Los Alamos was abandoned. The city currently obtains its water from wells hydrologically connected with the Rio Grande (Theis and Conover, 1960).

Numerous geologic and hydrologic studies have been made by LANL staff working on the HDR project. These studies have included drilling and testing of several exploratory wells which have provided subsurface data of ground water availability. Figure 5.

Figure 5

Site map of Fenton Hill showing location of observation, supply, exploratory, and geothermal well.

Source: Modified from unpublished data of Los Alamos National Laboratory 1981.

The presence of ground water at the Fenton Hill site was determined in 1974 by drilling and logging of Geothermal Test Hole GT-2. Ground water was noted at several different levels within this test hole. Water was present in several zones in the Abo Formation at depths of 780 to 1,120 ft. Logs indicate the yield of the sandstone in these zones would be low, probably less than 10 gpd/ft (gallons per day per foot). Six water-bearing horizons were present in the upper Madera Limestone at depths of 1,245 to 1,790 ft. These zones range in thickness from 10 to 30 feet. Zones of high permeability were also penetrated at depths of 1,848 and 1,905 feet below land surface.

According to Dan Miles, LANL geologist at the Fenton Hill site (personal communication 1980), all sedimentary samples from GT-2 are primarily red shales and sandstones, interbedded with finely crystalline, vari-colored limestone and gray to white sandstones of the Abo Formation. The zone between 1,000 and 1,050 feet consist mostly of loose, coarse, subrounded quartz grains and pebbles. The interval from 1,130 to 1,160 feet is almost a repeat of the above, although somewhat thinner. Other zones 830 to 850 feet and 870 to 900 feet consist of loose sand, more angular and finer.

The Madera Formation, below 1,230 feet is predominately a brown to white, finely crystalline to chalky limestone. Two possible water sands appear from 1,440 to 1,480 feet and from 1,520 to 1,540 feet. These are not as promising as the Abo sands described above. An arkosic sand which may contain water is found from 1,770 to 1,800 feet. Between 1,900 and 2,400 feet the samples were poor; however, additional exploration may be warranted.

A log analysis made by Birdwell Geophysical is given in Table 2.

Table 2

Evaluation of logs from well GT-2 made by Birdwell Geophysical

Depth (ft)	Description
820 - 850	About 25% porosity, but a poor water prospect in both holes. Slightly cleaner in GT-2.
1000-1050	18-20% porosity. Water appears to be relatively fresh. Should contain about 10 acre feet per acre drained. (Assuming a 40 acre drainage area and 30% recover factor, we should be able to produce 60,000,000 gallons from this zone.)
1130-1160	Does not appear too promising.
1440-1480	Tight and permeable.
1560-1590	13-17% porosity, with 34% porosity in 1560-1570 interval. The water appears brackish - about 5200 ppm (parts per million) salt equivalent.
1770-1800	Shaly, and a poor prospect in EE-1. Appears fair and possible in GT-2.
1900-2400	This is the lost circulation zone. It was not logged thoroughly enough for a Birdwell evaluation.

An exploratory hole (FH-1) was drilled in 1976. Table 3. This hole was completed in the Abiquiu Tuff and lower part of the Paliza Canyon Formation, at a depth of 450 feet. The lower 100 feet of these deposits are saturated, and it is these deposits which presently supply water to the Fenton Hill site. The aquifer is underlain by the Abo Formation which is generally impermeable. The upper surface of the Abo Formation has been dissected by erosion prior to the deposition of the volcanics, so that the thickness of this volcanic aquifer is quite variable.

Production from FH-1 has fluctuated since November, 1976 when the well was put in production. This is due to the varied demand for water at the site. Cumulative production from FH-1 from November, 1976 through December, 1980 was 20×10^6 gallons (61.4 acre feet). Static water level has declined from about 365 feet in 1976 to 371.67 feet in 1980.

An aquifer test was conducted in October and November, 1980. Ground water was withdrawn at a rate of 100 gpm for 9 days and water level recovery was measured for 18 days. About 1,300,000 gallons (4 acre feet) were discharged. The water level decline in the pumped well was 2.37 feet after 9 days pumping. The water level decline after 18 days recovery was 1.2 feet. All water level data were corrected for barometric effects.

The Abiquiu Tuff aquifer penetrated in well FH-1 between 350 and 450 feet probably is capable of supplying the estimated 59 acre feet required for site operation. This amount of pumpage from the aquifer is significant and allows little back up capability. In 20 to 25 years there is potential of experiencing technical problems. It is, therefore, wise to develop an alternate supply of water which could offset any future problems experienced. This alternate supply could range from hauling water, a change in plant design, to tapping the limestone aquifer below the Abiquiu.

Table 3

Geologic log of water supply well FH-1

Elevation at land surface - 8,700 feet

Depth (ft)	Description
------------	-------------

Bandelier Tuff	
0 - 26	Light gray-brown welded tuff; abundant quartz fragments; trace of sanidine.
26 - 53	Sticky light reddish-brown clay; embedded fragments of quartz and andesitic basalt
Paliza Canyon Formation	
53 - 70	Weathered andesitic basalt; probably gravel.
70 - 84	Friable, reddish, clayey tuffaceous sandstone; rounded grains
84 - 100	Black, white, clear, and orange chalcedony fragments; gravel or conglomerate
100 - 185	Fine grained, light, tuffaceous sandstone; mostly tightly cemented; 15% chalcedony fragments
185 - 189	Same as above, but somewhat clayey
189 - 200	Light reddish-brown clay; rounded basalt and chalcedony fragments
200 - 248	Weathered gravel
248 - 318	Gravel and rounded sand; conglomerate with basalt, Chalcedony, etc., probably large boulders. This looks like an angular gravel, loosely cemented by tuffaceous clay
318 - 333	Same as above, mostly basaltic gravel and angular quartz fragments
333 - 350	Same, with reddish and orange pebbles
Abiquiu Tuff (Water-bearing)	
350 - 380	Black basaltic gravel
380 - 445	Black, vesicular andesitic basalt boulders; cemented by a gummy sandy clay 422 - 424 and 430 - 445
445 - 450	Gravel and a small amount of loose rounded quartz sand
Abo Formation	

A monthly water use analysis should be carried out to determine the rate of water use for commercial development and operation. For example, is the water utilized at a constant rate or are there large demands made on the system periodically?

Some depletion of the Abiquiu aquifer has been experienced between 1976 and the present. Frequent water level measurements should be made in order to determine if this trend continues. It appears that the development of the Abiquiu aquifer at the Fenton Hill site is a local occurrence and there is no evidence that other water users have tapped it. Unless it is found that water from this aquifer contributes to streams in the area, and water rights would not be impaired and could not be replaced, it may be possible to obtain water rights from the Abiquiu aquifer. If the Abiquiu aquifer proves to be unable to meet the 59 acre feet per year requirement, it will be necessary to drill a test hole to a depth of about 2,400 feet. The limestone aquifers lie between 1,230 and 2400 feet and probably have the greatest potential for development. Costs to construct a well to those depths would exceed \$100,000. Studies and testing would be additional costs. These aquifers are known to produce water for springs in the Jemez River and its tributaries. In order to obtain water rights from these aquifers, it may be necessary to purchase and retire rights along this stream or to develop and implement an acceptable plan of replacement.

Surface Water

In the vicinity of the Fenton Hill site, surface water is present in the Jemez River and its tributaries (Figure 6). Base flow is from accretion of ground water to the streams from the near surface water table and from

FIGURE 6
 LOCATION OF SAMPLING STATIONS
 SOURCE: LOS ALAMOS NATIONAL LABORATORY
 REPORT LA-7830-HDR

large amounts of precipitation that occur in the high mountains. Flow discharge (years 1960 through 1975) of the Jemez River above Jemez Pueblo is shown in Table 4.

Surface water also is available from the Rio Grande. Base flow is derived from many tributaries which extend into the high mountains of New Mexico and Colorado. Surface water flow is published annually for various stations in New Mexico (U.S. Geological Survey, 1978). Discharge for the Rio Grande at Otowi Bridge near Los Alamos for the water year 1978 was 700,700 acre feet.

Surface water does not appear to be a viable source of water for the Fenton Hill Project. The site is located on a topographic divide between the Jemez River and the Rio Guadalupe, and the area is unsuitable for construction of a retention structure for impounding surface runoff. If surface water is required for operation of the HDR project, a structure would have to be constructed at some distance from the site, then piped to the facility.

All of the surface water rights in the Jemez River and the Rio Grande have been appropriated. Therefore, in order to use these water rights at the site, it will be necessary to purchase or lease rights elsewhere in the surface water system and transfer them to the site.

CHEMICAL QUALITY OF WATER

Ground Water

During the various studies that have been conducted in the vicinity of Fenton Hill, a large number of ground water samples have been collected and documented. These show a wide variety of chemical parameters ranging from excellent quality to highly mineralized. This is not uncommon in a complex geologic and geothermal area such as the Jemez Mountains.

Table 4 Surface water records of the Jemez River near Jemez Pueblo near Location R

Year	<u>Discharge m³/s (ft³/s)</u>		Mean Annual	Annual Volume
	Minimum	Maximum		hm ³ (x 10 ³ ac-ft)
1960	0.28 (10)	16.8 (595)	2.1 (74)	66.5 (53.9)
1961	.45 (16)	24.9 (880)	2.5 (87)	77.8 (63.1)
1962	.40 (14)	19.2 (675)	2.3 (81)	72.3 (58.6)
1963	.27 (9.6)	17.0 (600)	1.2 (42)	37.7 (30.6)
1964	.31 (11)	9.6 (340)	.99 (35)	31.1 (25.2)
1965	.45 (16)	11.3 (400)	1.9 (68)	60.7 (49.2)
1966	.28 (10)	12.7 (450)	1.4 (51)	45.6 (37.0)
1967	.27 (9.7)	9.9 (350)	1.0 (36)	31.9 (25.9)
1968	.42 (15)	21.8 (770)	2.4 (84)	75.5 (61.2)
1969	.45 (16)	14.2 (500)	2.6 (92)	81.7 (66.3)
1970	.42 (15)	13.2 (465)	1.8 (65)	57.8 (46.9)
1971	.24 (8.3)	6.8 (240)	1.2 (42)	37.4 (30.3)
1972	.28 (9.9)	6.5 (230)	1.3 (46)	40.8 (33.1)
1973	.37 (13)	64 (2260)	4.8 (170)	161.2 (130.7)
1974	.31 (11)	4.8 (170)	1.1 (38)	34.2 (27.7)
1975	.48 (17)	48 (1710)	3.4 (120)	103.4 (83.9)

The present water supply at Fenton Hill is obtained from Well FH-1 in which the principal ions are calcium and bicarbonate. Concentration of these ions has shown no significant change from 1976 through 1978 (Table 5). The average concentration of total dissolved solids has increased during the same period. In July, 1976, the total dissolved solids were 104 mg/l (milligrams per liter), whereas in May, 1980, the total dissolved solids had increased to 252 mg/l. Some deterioration of water quality is not uncommon during the period of production.

Water from FH-1 was analyzed for chemical and radiochemical constituents to compare with the standards set for municipal and domestic use by the U.S. Environmental Protection Agency and State of New Mexico standards. A comparison of analytical results of water from the well to these standards show that the water is within limits set for municipal use. Table 6.

The concentration of silica generally exceeds 60 mg/l in water from Well FH-1, and this may cause some scale to form when used in a heated, closed system. The other major ions, such as calcium, magnesium, and bicarbonate, are not likely to have a severe effect on usage. In general, the water quality is acceptable for most industrial uses.

If it is necessary to produce ground water from the deep limestone aquifers, high mineralization of water should be anticipated. Only one sample has been collected from these water bearing units beneath the site. A sample was obtained from Well GT-2 which contained 115 mg/l silica, 550 mg/l sodium, 1,230 mg/l bicarbonate, and total dissolved solids of 2,500 mg/l.

Table 5 Chemical quality of water from supply well FH-1.

Date	mg/l										TDS	Total Hardness	Specific Conductance (µmho)	pH
	SiO ₂	Ca	Mg	Na	CO ₃	HCO ₃	SO ₄	Cl	F	NO ₃				
7/27/76	61	36	2	14	0	112	15	8	0.1	0.4	104	100	240	8.0
11/19/76	70	31	4	11	0	107	<1	7	.2	<.4	202	94	240	7.6
6/ 3/77	73	32	3	11	0	110	<1	6	.2	.4	210	91	250	8.0
11/18/77	67	33	4	10	0	108	9	8	.1	.4	184	101	220	8.3
5/17/78	53	31	4	14	0	108	6	10	.3	<.4	338	95	450	7.6
12/ 5/78	73	38	5	9	0	112	10	13	.3	.8	232	116	280	7.5
7/ 9/79	64	38	5	16	0	112	7	18	.2	2.2	243	116	260	7.9
11/ 9/79	68	37	6	18	0	110	7	19	.5	1.3	244	119	330	7.1
5/27/80	66	36	5	13	0	112	10	12	.2	1.0	252	110	250	7.5

Table 6 Chemical and radiochemical concentrations in water from supply well, 1979.

Chemical (mg/l)	Supply Well FH-1	Standard or Criteria
Ag	< 0.001	0.05
As	< .001	.05
Ba	< .5	1.0
Cd	.01	.010
Cl	19	250
Cr	< .002	.05
F	.3	2.0
Hg	.0005	.002
NO ₃	1.5	45
Pb	.002	.05
Se	< .005	.01
TDS	244	1,000

Radiochemical (pCi/l)

³ H	0.6	20
¹³⁷ Cs	80	200
²³⁸ Pu	.03	7.5
²³⁹ Pu	.04	7.5
Gross alpha	2.3	5
Total U	1.9	1,800

The chemical quality of water produced from Well Fh-1 is potable and meets the requirements set by federal and state regulatory agencies. Total mineralization from this well tapping the Abiquiu aquifer is about 250 mg/l dissolved solids; the silica levels generally are greater than 50 mg/l and may cause some scale to form when used in a heated, closed system. Water from the deep limestone aquifers are highly mineralized and probably would require a high level of treatment for use in the HDR project.

Surface Water

In 1973, a study was made of the water quality in the vicinity of the Fenton Hill site to establish base-line water quality data before experimental work commenced. Water samples were collected from the immediate drainage area of the site and in the major drainages of the Rio Guadalupe and Jemez River. In general, water from these streams was similar in chemical quality to the ground water produced from Well FH-1.

The silica levels in the surface water sources were somewhat lower, with an average of six samples being 37 mg/l silica. Total dissolved solids were generally less than 500 mg/l. It should be noted that the amount of mineralization in the stream was a function of discharge. The mineralization in samples collected during the spring runoff was approximately half the amount present during low-flow periods in the winter.

The chemical quality of water from the Jemez River and Rio Guadalupe varies with stream discharge. Highest levels of mineralization occur during the low-flow periods of winter and early spring. Use of surface water will require a plant design with a treatment facility capable of using a wide range of water chemical makeup. Also, filtration to remove suspended sediment will be required.

WATER RIGHTS

The New Mexico water law is based on the doctrine of "prior appropriation" in which the first user of water for beneficial purposes has senior rights to a later user of water from the same source. When the surface water or ground water, or both, are completely appropriated to beneficial uses, the State Engineer of New Mexico will close the water basin to further appropriation. Where additional water is unavailable for appropriation, it is common practice to purchase or lease the existing water rights from individuals in whom the right to the water is vested; a plan of replacement approved by the State Engineer and implemented by the appropriator may be used to avoid an impairment of existing water rights which would otherwise cause the State Engineer to deny an application to appropriate groundwater. The beneficial use of the water shall be the basis, the measure, and the limit of the right, to the use of the water. Because the water right is appurtenant to the land upon which it has been placed to beneficial use, an individual who anticipates a new use of water at a different location must apply to the State Engineer for a permit to change the place of use and point of diversion of water.

The Fenton Hill site is located within the Rio Grande Underground Water Basin as declared by the State Engineer on November 29, 1956, and extended on September 7, 1973. As defined by the State Engineer, the Rio Grande Basin extends from the Colorado-New Mexico border southward to Elephant Butte Dam. It includes most of the Rio Grande drainage area and several of the major population centers of the State are located in the basin, including Los Alamos and Albuquerque.

The State Engineer recognizes that there is a direct hydrologic connection between the surface water in streams and in the ground water.

Development of one source may directly impact the other. Therefore, it is necessary to make application for water rights from either a ground water or a surface water source in order to divert and utilize water within the basin.

Existing Water Rights

The State Engineer has approved an application for permit for water to be used in HDR research at Fenton Hill. The permit number is RG-4834. The amount of water approved was 18 acre feet for the year 1978 and 15 acre feet for each of the following years through 1986. The permit will be automatically cancelled on January 1, 1987.

In granting this application for water useage at Fenton Hill, the State Engineer determined that there would be no adverse impact or impairment to prior waters users, based on the proposed amount and duration of use.

A potential developer of the HDR site will have to make an application for 59 acre feet of ground water.

The State Engineer can grant this application with or without restrictions. Consequently the application should be submitted with documentation supporting the application. Although all of the water in the Rio Grande basins has been appropriated, this only applies to the ground water or surface water that is hydrologically connected with the Rio Grande itself. It is possible that production of 59 acre feet of ground water for a period of 30 years would not impact the Rio Grande or its tributaries. Therefore the supporting documentation should thoroughly evaluate the long term effects on the aquifer and related ground water and surface water sources in the vicinity of Fenton Hill.

If the State Engineer grants the application with acceptable restrictions, a developer should have sufficient water for plant operations. However, if the State Engineer determines that, by granting the application, prior water rights will be impaired then the rights can be granted provided that the developer agrees to offset the impairment under an approved and implemented plan of replacement or by acquiring and retiring existing water rights.

Impairment can be offset by retiring water rights that presently are available; however, the amount of retirement is difficult to determine within the scope of this study. It can be assumed that, if the water rights were granted and retirement of water rights was necessary, the amount of retirement probably would not exceed 30 acre feet per year.

Availability of Water Rights

If it is necessary for a developer to retire water rights in order to produce 59 acre feet of ground water per year, the rights to be retired can be obtained from various sources, including municipal, industrial, and/or agricultural.

A number of water rights have been granted to various water users in the vicinity of Los Alamos and the Fenton Hill site. Perhaps the largest water user is Los Alamos County which produces water from a well field east of the city. Although the County currently has a surplus of about 5,200 acre feet per year, it is expected that this will be fully obligated by 1982. Consequently it is not considered a viable source of water.

The City of Albuquerque presently has a surplus of water available, some of which is being leased to other water users in the area. The city is

giving a maximum lease of 10 years with a 5-year city option at an approximate cost of \$40.00 per acre foot per year. Inasmuch as both Albuquerque and the Fenton Hill site are in the Rio Grande basin, it is possible that the State Engineer might allow a developer to acquire and retire rights at Albuquerque in order to offset impairment to the basin at Fenton Hill.

In the Jemez River drainage system there are a number of water users who own small tracts of agricultural land. These areas most often are located along streams from which the water is diverted. These include the areas of La Cueva, the village of Jemez, and downstream at the Jemez Pueblo and at San Ysidro. The consumptive rights of 30 acre feet per year for industrial use would be the irrigation equivalent of about 45 acres of land. Therefore it would be necessary for the developer to purchase or lease the irrigation rights for 45 acres of agricultural land.

At the present time, water rights in the Rio Grande valley are selling for a maximum of about \$3,000 per acre foot, although the market fluctuates widely. There is no record of water rights being sold in the Jemez drainage within the past few years, except in very small parcels. Therefore the price would be difficult to estimate.

An application should be filed by a developer for 59 acre feet of water rights in the Rio Grande basin. This water could be withdrawn from Well FH-1 which taps the Abiquiu aquifer and the water will be totally consumed. The duration of the application should be 30 years or longer, depending on the projected needs of the developer. When acting on the application, the State Engineer will determine whether or not it is necessary for a developer to replace or retire existing water rights in the

same basin. If retirement is necessary, the State Engineer will make a determination regarding the point of retirement and method. If it is determined that water rights must be retired by a developer, there are several options available which could be submitted to the State Engineer:

- a. Lease and temporarily retire water rights from the City of Albuquerque.
- b. Purchase or lease of agricultural water rights in the Rio Grande valley.
- c. Purchase or lease agricultural water rights in the Jemez drainage system.

Depending on which options are available and exercised, the cost of these water rights could range from a filing fee of \$1.00 to as much as \$135,000.00 for purchase of 45 acre feet of agricultural water rights. Additional expenses of \$5,000 or less would be required to provide the hydrologic documentation to support the water rights application.

WASTE WATER DISPOSAL AT FENTON HILL

Three ponds have been used at the site to store water produced by experimental use and drilling operations. The upper pond (GTP-1) has a surface area of about 11,200 square feet. The middle pond (GTP-2) has a surface area of about 3,000 square feet, and the lower pond (GTP-3) has a surface area of about 6,500 square feet.

The water used in experiments or drilling operations is returned to the ponds for reuse, thus the quality of water deteriorates with time. During 1978, chloride concentrations ranged from 33 to 495 mg/l in GTP-1, from 68 to 2,133 mg/l in GTP-2, and from 126 to 1,256 mg/l in pond GTP-3. The analysis of water from twelve auger holes showed a decrease in

concentration of chloride, fluoride, and total dissolved solids with increasing distance from the ponds.

The decrease in mineralization away from the ponds is due to absorption of ions by alluvial material and uptake by plants with some minor dilution by natural storm runoff and precipitation. Thus it appears that the clay soils near the site would be suitable for retention of small amounts of waste products; however, only lined ponds should be considered for long term disposal.

Three disposal ponds are being used at the Fenton Hill site for storage and disposal of waste water. Some leakage is known to have occurred; however, the clay soil has been a moderately effective cleaning agent. The ponds now in use at the site should not be required by a developer during operation of the project. Therefore, a developer should not be responsible for the level of mineralization in the soils at the time responsibility for the site changes from LANL to the developer. Any long range storage of waste should consider the use of lined ponds which would minimize leakage to the soil and drainage systems.

CONCLUSIONS AND RECOMMENDATIONS

Fifty-nine acre feet of water is that amount estimated to meet the annual operation of needs of the Fenton Hill HDR project. This amount of water should be, for all intents and purposes, available from the Abiquiu Tuff aquifer which is currently tapped by Well FH-1. The testing that has been completed to date is fully adequate to make this assumption. It is also assumed that the existing equipment used to operate this well will be transferred to the commercial developer. Costs for the physical development and operation of a water source are small for the initial operation of stages of the HDR project since the well would already be in place.

The Abiquiu Tuff aquifer is not currently known to be interconnected with surface water supplies in the area nor is there any other known user of the aquifer. Additional studies should be carried out to verify these assumptions. If there are no exceptions to these assumptions, then water rights from the aquifer can be applied for at no cost other than a filing fee. The study costs and filing fee should not exceed \$5,000.

If the aquifer is interconnected with streams in the area, then certain water rights along those streams would have to be acquired to meet the operational water needs of the project. These costs could range as high as \$135,000. It will be necessary for a potential developer of the HDR site to make application for 59 acre feet of water per year. It should be noted that the existing permit RG4834 will expire in 1987.

If, for some reason, the Abiquiu Tuff aquifer were depleted, then deeper limestone aquifers could be tapped or surface water rights acquired. Both options would entail more expense. The limestone aquifer would be easier to tap, but would cost more money. The surface rights are cheaper, but more difficult to acquire.

Water quality from the Abiquiu aquifer is acceptable for most industrial purposes. However, silica may cause some scaling.

Based on all the above, and upon assumptions made, there appears to be an adequate water supply for commercial development of the HDR project. A secondary source should be investigated to provide for unseen water requirements.

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TRANSMISSION REQUIREMENTS

METHODOLOGY

This section of the HDR Feasibility Study addresses possible transmission paths to carry electrical energy from the HDR generation facility at Fenton Hill to existing and potential points of interconnection with existing transmission systems. This section analyzes each feasible transmission path and considers each option in terms of known capital costs, power loss factors, right-of-way acquisition costs, and reliability considerations. Based on these discussions, conclusions have been developed and a recommendation is offered.

EXISTING AND PLANNED FACILITIES

Jemez Mountains Electric Cooperative, Inc. (JMEC) owns and operates both 24.9 KV distribution and 69KV transmission lines in the area of the HDR project. There exists a 24 mile, 24.9 KV line from JMEC's Jemez Pueblo Substation to Fenton Hill HDR and a 15 mile 24.9 KV line from Fenton Hill to JMEC's Nacimiento Substation. The 69KV line runs from Plains's La Jara Substation to JMEC's Cuba Substation and from Cuba Substation to Nacimiento Substation, as well as from Plains' San Ysidro Substation to Jemez Pueblo Substation.

Proposed lines in the area include a 69KV line from the proposed La Ventana Tap southward to the proposed La Ventana Substation which is the site of the proposed Ideal Basic facility and a 115KV line from Los Alamos to PNM's Baca No. 1 Geothermal Project. The Baca Project is being planned independently of the HDR Project and, depending upon economic, political and other factors, may or may not come on-line to match the timing of the HDR project. See Figure 7 showing the existing and proposed system.

FIGURE 7
EXISTING AND PROPOSED
TRANSMISSION SYSTEMS

TRANSMISSION ALTERNATIVES

The following transmission alternatives have been identified and analyzed:

- 1) Utilizing the existing JMEC 24.9KV distribution systems from either Nacimiento or Jemez Pueblo Substation;
- 2) Utilizing the existing JMEC 24.9KV distribution systems as in (1) and reconductoring the line with 477 MCM ACSR;
- 3) Constructing a 15 mile 24.9KV, 477 MCM ACSR line from HDR to Nacimiento Substation;
- 4) Constructing a 24 mile 69KV, 477 MCM ACSR line from HDR to Jemez Pueblo Substation;
- 5) Constructing a 15 mile 69KV line from HDR to Nacimiento Substation;
- 6) Constructing an 18 mile 69KV line from HDR to the proposed La Ventana Substation;
- 7) Constructing a 10 mile 24.9KV line from HDR to Baca No. 1;
- 8) Constructing a 10 mile 69KV line from HDR to Baca No. 1; and
- 9) Constructing a 10 mile 115KV line from HDR to Baca No. 1.

ASSUMPTIONS

Figures in this section represent costs in 1981 dollars. The assumptions are based on information generated by Plains and from information supplied by JMEC and LANL.

It is assumed the HDR project generating facility will generate 10MW at a capacity factor of at least 85.6 percent over the long term. It is assumed that it costs as much to reductor a line as to build a new line. Reconductoring in mountainous terrain with many angles and guying problems

generally requires replacement of most, if not all, structures. An additional expense is incurred in removing the old materials before new construction can begin. Right-of-Way easements and permits often must be renegotiated and landowners compensated for construction damages.

Project transmission lines are assumed to be financed at a 12 percent interest rate, which computes to a fixed annual charge of 16.28 percent. Based on current charges for wheeling, it is assumed JMEC will charge \$3.723/KW year and PNM will charge \$12.00/KW year.

It is assumed that right-of-way acquisition is possible from a legal and environmental standpoint. In addition, the HDR developer of a utility or rural electric cooperative may utilize the right of eminent domain on privately held lands. Environmental concerns will be studied in detail if the project is considered feasible. At that time a specific routing of the transmission line can be determined and applicable environmental precautions taken. There appear to be no engineering problems that would stop development of any transmission alternative.

COST DATA

Costs per mile for distribution/transmission lines are as follows:

24.9KV, 477 MCM ACSR line	\$ 24,000
69KV, 4/0 ACSR line	49,000
115KV, 266.8 MCM ACSR line	65,000

When it is necessary to construct lines over rough terrain, the cost per mile is increased by 20 percent.

The following costs are associated with the labor, material and equipment necessary to interconnect the transmission facility with the generation station and the point of delivery into the transmission grid:

Site preparation at each point of Interconnection*	\$100,000
24.9 Breaker Bay	75,000
69KV Breaker Bay	100,000
115KV Breaker Bay	150,000

Station service facilities at the HDR site to run pumps, fans, etc.

24.9KV	\$170,000
69KV	185,000
115KV	200,000

*Site preparation costs include grading, fencing, cost of land, and other items appurtenant to the interconnection. It is assumed that the proposed stations will be designed and constructed to accommodate the interconnection. Consequently, site preparation costs are not included in the economic analysis of the proposed stations.

The results of power loss cost calculations will be included in the economic analysis of each alternative.

ECONOMIC ANALYSIS OF ALTERNATIVES

The evaluation of the following nine alternatives is based primarily on economics. The differences in terrain are taken into account by adding 20 percent of the capital cost of the line, where that line is expected to cross rough terrain. Land ownership and wheeling costs are also considerations. Those alternatives that have large percentages of the right-of-way on federal lands offer advantages over those that are made up of many ownerships or that are on Indian lands. Wheeling costs that are charged by member cooperatives may be more attractive than non-Cooperative charges.

Alternative I

Alternative I consists of tapping into JMEC's distribution system as it now exists. It has been assumed that the HDR project will generate 10MW of electricity. The existing distribution system has 1/0 ACSR conductor with a thermal rating of 9.9 MVA which is insufficient for the HDR output. Losses incurred by operation of the distribution system at this load level would be extremely high. Due to the above problems this alternative is dropped from further consideration.

Alternative II

This alternative contemplates reconductoring JMEC's existing distribution system with 477 MCM ACSR which has a thermal rating of 28.9 MVA. Problems associated with this alternative include the following:

- 1) Costs for reconductoring would be the same as for new construction;
- 2) Electrical service to existing customers could not be maintained during reconductoring, thereby creating long outages; and
- 3) The HDR generator output would be subject to distribution system faults and outages impairing the reliability of the project.
- 4) Acquisition of additional right-of-way from Jemez Pueblo would be time consuming and costly.

Due to these problems, this alternative has been dropped from further consideration.

Alternative III

Alternative III consists of constructing a 15 mile, 24.9KV line to Nacimiento Substation, expansion of the Nacimiento Substation, and replacement of the existing 24.9KV OCR and 24.9KV transformer. The costs for each item break down as follows:

15 miles, 24.9KV, 477 MCM ACSR line @ \$24,000/mi	\$ 360,000
Plus 20% rough terrain adder	72,000
Site development at HDR	100,000
2 ea. 24.9KV Breaker Bays at HDR @ \$75,000 ea.	150,000
Auxiliary Transformer and associated facilities at HDR	170,000
1 ea. 24.9KV Breaker Bay at Nacimiento Substation	75,000
Installation of 10/12.5 MVA Transformer at Nacimiento	<u>200,000</u>
Capital Cost	\$1,227,000
Fixed Annual charges	199,756
Annual power loss costs	102,501
JMEC wheeling Charge @ \$3.723/KW Year	<u>37,230</u>
Annual Cost	\$ 339,487

It is estimated that 80 percent of the land to be acquired for right-of-way is federally owned and 20 percent privately owned. Right-of-way acquisition is estimated to take from 24 to 30 months. This alternative avoids Indian lands. The proposed transmission route will avoid wilderness, recreation areas and wildlife management areas. There are no

known endangered flora or fauna, no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary.

An archaeological survey will have to be carried out. The route will pass through commercial timber but there should be no problems associated with this issue.

Alternative IV

This alternative consists of the construction of a 24 mile 69KV line from HDR to Jemez Pueblo Substation, modifications to Jemez Pueblo Substation, and the replacement of San Ysidro transformer. Cost details are as follows:

24 miles, 69KV, 4/0 ACSR line @ \$49,000/mi	\$1,176,000
Site development at HDR	100,000
Site development at Jemez Pueblo Substation	100,000
2 ea. 69KV Breaker Bays at HDR @ \$100,000	200,000
3 ea. 69KV Breaker Bays at Jemez Pueblo @ \$100,000	300,000
Auxiliary transformer and associated facilities at HDR	185,000
Installation of 10/12.5 MVA transformer at San Ysidro	200,000
Acquisition of 5 miles of rights of way over Jemez Pueblo lands	<u>200,000</u>
Capital Cost	\$2,416,000

Fixed Annual Charges	400,651
Annual power less costs	43,996
JMEC wheeling charges @ \$3.723/KW Year	<u>37,230</u>
Annual Cost	\$ 481,877

It is estimated that 20 percent of the lands to be acquired for right-of-way is across the Jemez Pueblo. Due to the Pueblo's opposition to geothermal development in the Jemez Mountains, it is expected that the Pueblo would be reluctant to grant the necessary easements and, if the easement were granted, the cost would be very high and the timing for acquisition lengthy. Because this alternative passes through Indian lands, it is not considered a good option for further evaluation.

Alternative V

Alternative V consists of the construction of a 15 mile, 69KV line from HDR to Nacimiento Substation and modifications to that substation. Adequate transformer capacity exists at the La Jara 115/69KV Substation and transformer replacement is not required. Costs break down as follows:

15 miles, 69KV, 4/0 ACSR line @ \$49,000/mi	\$ 735,000
plus 20% rough terrain adder	147,000
Site preparation at HDR	100,000
Site preparation at Nacimiento Sub	100,000
2 ea. 69KV Breaker Bays at HDR @ \$100,000 ea.	200,000
3 ea. 69KV Breaker Bays at Nacimiento @ \$100,000 ea.	300,000

Auxiliary transformer and associated facilities @ HDR	<u>185,000</u>
Capital Cost	\$1,767,000
Fixed Annual Charges	287,670
Annual Power Loss Costs	27,498
JMEC Wheeling Charges @ \$3.723/KW Year	<u>37,230</u>
Annual Cost	\$ 352,398

It is estimated that 80 percent of the land to be acquired for right-of-way is federally owned and 20 percent privately owned.

Right-of-way acquisition is estimated to take from 24 to 30 months. This alternative avoids Indian lands. The proposed transmission route will avoid wilderness, recreation areas and wildlife management areas. There are no known endangered flora or fauna, no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary.

An archaeological survey will have to be carried out. The route will pass through commercial timber but there should be no problems associated with this issue.

Alternative VI

Alternative VI consists of the construction of an 18 mile 69KV line from HDR to the proposed JMEC La Ventana Substation. The substation is planned to be built in 1982-83 to serve Ideal Basic, which is assumed to be a 10 MVA load with a high load factor. Cost details are as follows:

18 miles, 69KV, 4/0 ACSR line @ \$49,000 mi.	\$ 882,000
Site preparation at HDR	100,000
2 ea. 69KV Breaker Bays at HDR @ \$100,000 ea.	200,000
2 ea. 69KV Breaker Bays at La Ventana @ \$100,000 ea.	200,000
Auxiliary transformer and associated facilities at HDR	<u>185,000</u>
Capital Cost	\$1,567,000
Fixed annual charges	325,335
Annual Power Loss Costs	32,997
JMEC Wheeling Charges @ \$3.723/KW Year	<u>37,230</u>
Annual Cost	\$ 255,108

It is estimated that 70 percent of the land to be acquired for right-of-way is federally owned and 30 percent privately owned. A portion of the private land is held by Ideal Basic and they could be expected to be cooperative in granting any easements. Right-of-way acquisition is estimated to take from 20 to 24 months. This alternative avoids Indian lands. The proposed transmission route will avoid wilderness, recreation areas and wildlife management areas. There are no known endangered flora or fauna, no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary.

An archaeological survey will have to be carried out. The route will pass through commercial timber but there should be no problems associated with this issue.

Alternative VII

This alternative consists of construction of a 10 mile 24.9KV line from HDR to PNM's Baca No. 1 Geothermal Project location, usage of Baca's

115KV facilities, and associated costs. Cost details are as follows:

10 miles, 24.9KV, 477 MCM ACSR @ \$24,000/mi.	\$ 240,000
Site development at HDR	100,000
2 ea. 24.9KV Breaker Bays at HDR @ \$75,000 ea.	150,000
1 ea. 24.9KV Breaker Bay at Baca	75,000
1 ea. 115KV Breaker Bay at Baca	150,000
Auxiliary transformer and associated facilities at HDR	170,000
24.9/115KV 10/12.5 MVA transformer at Baca*	<u>350,000</u>
Capital Cost	\$1,235,000
Fixed Annual Charges	201,058
Annual Power Loss Costs	68,334
PNM Wheeling Charges @ \$12.00/KW Year	<u>120,000</u>
Annual Cost	\$ 389,392

* This cost is higher than what was shown in Alternative III and Alternative IV because there is no existing transformer salvage value to reduce the cost of the new transformer.

It is estimated that 50 percent of the land to be acquired for right-of-way is federally owned and 50 percent privately owned.

Right-of-way acquisition is estimated to take from 18 to 24 months. This alternative avoids Indian lands. The proposed transmission route will avoid wilderness, recreation areas and wildlife management areas. There are no known endangered flora or fauna, no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary.

An archaeological survey will have to be carried out. The route will pass through commercial timber but there should be no problems associated with this issue.

Alternative VIII

Alternative VIII consists of the construction of a 10 mile, 69KV line from HDR to Baca location, usage of Baca's 115KV facilities and associated costs. Cost details are as follows:

10 miles, 69KV, 4/0 ACSR line @ \$49,000/mi.	\$ 490,000
Site preparation at HDR	100,000
2 ea. 69KV Breaker Bays at HDR @ \$100,000 ea.	200,000
1 ea. 69KV Breaker Bay at Baca	100,000
1 ea. 115KV Breaker Bay at Baca	150,000
Auxiliary transformer at associated facilities at HDR	185,000
69/115KV 10/12.5 transformer at Baca*	<u>350,000</u>
Capital Cost	\$1,575,000
Fixed Annual Charges	256,410
Annual Power Loss Costs	18,332
PNM Wheeling Charges @ \$12.00KW/Year	<u>120,000</u>
Annual Cost	\$ 394,742

* This cost is higher than what was shown in Alternative III and Alternative IV because there is no existing transformer salvage value to reduce the cost of the new transformer.

It is estimated that 50 percent of the land to be acquired for right-of-way is federally owned and 50 percent privately owned. Right-of-way acquisition is estimated to take from 18 to 24 months. This alternative avoids Indian lands. The proposed transmission route will avoid wilderness, recreation areas and wildlife management areas. There are no known endangered flora or fauna, no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary.

An archaeological survey will have to be carried out. The route will pass through commercial timber but there should be no problems associated with this issue.

Alternative IX

Alternative IX consists of the construction of a 10 mile, 115KV line from HDR to Baca, usage of Baca's 115KV facilities and associated costs.

Cost details are as follows:

10 miles, 115KV, 266.8 MCM ACSR line @ \$65,000	\$ 650,000
Site preparation at HDR	100,000
2 ea. 115KV Breaker Bays @ \$150,000 ea.	300,000
1 ea. 115KV Breaker Bay @ \$150,000 ea.	150,000
Auxiliary transformer and associated facilities at HDR	<u>200,000</u>
Capital Cost	\$1,400,000
Fixed Annual Charges	227,920
Annual Power Loss Costs	5,191
PNM Wheeling Charges @ \$12.00KW/Year	<u>120,000</u>
Annual Cost	\$ 353,111

A summary comparison of alternatives is given in Table 7.

TABLE 7

Cost Comparison of Alternatives

<u>Alternative</u>	<u>Capital Cost</u>	<u>Power Loss Cost</u>	<u>Annual Cost</u>
III	\$ 1,227,000	\$ 102,501	\$ 339,487
IV	2,461,000	43,996	481,877
V	1,767,000	27,498	352,398
VI	1,567,000	32,997	255,108
VII	1,235,000	68,334	389,392
VIII	1,575,000	18,332	394,742
IX	1,400,000	5,191	353,111

EXISTING POLICY AND AGREEMENTS

As an existing corporate policy, Plains constructs, operates, and maintains power transmission facilities of 115KV and above while member distribution cooperatives own facilities of 69KV and below. Plains has an existing wheeling agreement with JMEC to wheel Plains' power over a 69KV line to serve Northern Rio Arriba Electric Cooperative. Similar agreements would need to be reached with JMEC to wheel power from the HDR Project. Plains also has interconnection and wheeling agreements with PNM and it may be necessary for Plains and PNM to negotiate additional agreements to provide for transmission of power out of HDR. Included in these agreements with either JMEC or PNM would be an arrangement detailing actual ownership of facilities. It is expected that these agreements can be reached without significant difficulty.

CONCLUSIONS AND RECOMMENDATIONS

Alternative VI, a 69KV line constructed from HDR to the proposed JMEC La Ventana Substation, is the preferred alternative. This selection is based upon the following:

1) Construction of this facility would allow the entire output of the HDR project to be absorbed by the projected 10 MW demand of JMEC. By utilizing the electric power in the JMEC system, transmission costs are saved. No better utilization of the HDR generation capability is indicated in any other alternative;

2) Alternative VI is the least expensive;

3) Approximately 70 percent of the right-of-way is USFS ownership in Alternative VI; and

4) Wheeling costs of this alternative are advantageous.

A major advantage of this alternative is that it crosses no Indian lands. This route will avoid wilderness, recreation, and wildlife management areas. There are no known endangered flora or fauna; no prime range or farm lands, or registered historic sites. Air and water quality concerns will be temporary. An archaeological survey will have to be done.

Lead times for right-of-way acquisition are estimated to be 24 to 30 months. The maximum lead time on environmental permits would be 26 months.

ENVIRONMENTAL ISSUES

METHODOLOGY

The identification of environmental issues impacting the HDR project was based upon the review of existing environmental reports and data from LANL, DOE, and data developed for the Baca Hydrothermal project. A site visit was made to develop a clear picture to relate past reports to current and future activities. In addition, interviews were conducted with State regulatory agencies to identify state environmental concerns and requirements. Although the majority of the available data related to the experimental HDR project, the similarities between the experimental facility and commercial facility were sufficient to make reasonable predictions as to problem areas with a commercial HDR facility.

DESCRIPTION OF PREVIOUS WORK

LANL began active work on HDR in 1970 under authority of the U.S. Atomic Energy Commission (AEC). The Fenton Hill Site was selected in 1973 for the location of the experimental facility. Since the selection of the site, LANL has conducted an extensive environmental assessment and monitoring program. Studies included noise, water, air, socioeconomics, archaeology, flora, fauna and geology with emphasis on siesmology. Expanded studies have assessed the impact of an experimental HDR geothermal project. All studies have been combined into one report "Environmental analysis of the Fenton Hill Hot Dry Rock Geothermal Test Site" LA7830-HDR issued May, 1979.

ENVIRONMENTAL AREAS OF IMPORTANCE

Due to the unique energy (heat) source of an HDR generating unit, many typical environmental problems associated with a fossil fuel facility (coal or

oil) are either eliminated or greatly reduced. However, impacts to the environment will occur and must be adequately addressed. This report will examine areas of environmental concern and assess their impact on the viability of the HDR project.

Archaeology and Seismology

The HDR site is located at Fenton Hill on the Jemez Plateau approximately 35 KM (21 Mi.) West of Los Alamos at an elevation of 8660 feet. The Plateau is a product of volcanic activity some 1.1 million years ago which also produced the Valles Caldera.¹

Archaeological studies were carried out by C. R. Steen, a private consultant,² C. Scheick of the School of American Research (SAR)³ and D. Winner of the USFS⁴. No significant finds were made. The SAR investigator noted that the high elevation and lack of a permanent water source would probably preclude permanent settlements. However, temporary sites, such as hunter camps and chipping stations may exist but are obscured by the low ground vegetation resulting from a major fire years earlier at the site. To address such a situation, the SAR consultant for LANL suggested that any new ground breaking be checked for archaeological significance.³ In the unlikely event that some sites are discovered during construction, satisfactory mitigation procedures exist. These include avoidance and site excavation. Mitigation procedures would be developed in consultation with the State Historic Preservation Officer (SHPO).

If new transmission facilities are needed for the project, an archaeological survey will be needed along the right-of-way. Any required mitigation can be easily accomplished to avoid significant impact.

Since the Jemez Plateau was formed by volcanic activity, the geology and seismology of the area were analyzed for possible adverse impact to the construction and operation of a commercial HDR generating facility. An extensive survey to locate faults and seismic events was conducted by LANL. The survey, performed in 1971, showed that the Jemez Fault Zone was the nearest major fault system to the site. Two northeast trending faults within this zone, the Virgin Canyon Fault and the Jemez Springs Fault, pass within 4 to 7 km, respectively of the site. Field checks of both faults indicate their displacement is far below that of major active faults in the Western United States. The fact that these faults trend away from the site and have a relatively low displacement, indicates little chance of natural seismic problems occurring with the site, nor would it be likely that the construction or operation of a commercial HDR generating facility would activate the faults. Two sets of seismic nets (close-in and on-site) were established and used in conjunction with LANL's existing 12 station regional system. Seismic monitoring of drilling and reservoir fracturing by LANL to date have not recorded a measurable surface seismic event caused by the operations at the project.

Air, Water, Noise and Radiation

Air quality impacts during construction will be limited to fugitive dust emissions and exhaust from construction vehicles. The use of proper dust control techniques, such as the use of dust control agents, will reduce the fugitive dust problem to an insignificant level. During commercial operations, the only air pollution problems will be associated with the release of dissolved gases during the venting of the pressurized geothermal fluid system. Two potential pollutants can be found in the vented exhaust, hydrogen sulfide

and ammonia.⁹ Measured levels of these gases are so low (trace or threshold of detection) that neither State nor Federal permits will be needed for their discharge into the atmosphere during venting.⁵ In addition, ambient levels of hydrogen sulfide during venting should be well below the odor threshold (.5ppb) at the property line.^{1, 11} There may also be some potential for thermal impact to trees near the cooling system exhaust from the generation facility due to forced winter transpiration induced by warm air passing over the tree leaves.¹² Impact would be very localized.¹

Water quality impacts are related to the buildup of contaminants in the pressurized geothermal fluid and the release of these contaminants to ground or surface waters.

Although the system is designed to be a completely closed system, periodic or emergency maintenance may require venting of a portion of the geothermal liquid. If contaminant concentrations exceed State and/or Federal discharge limits, some treatment may be required prior to release to surface or ground water. Conventional water treatment systems are available to adequately treat the geothermal fluid so that the discharge will meet all applicable state and local standards. It is noted that the present LANL project has a valid National Pollutant Discharge Elimination System (NPDES) permit, and that the proposed commercial operation's quality and quantity of discharge would be similar to that currently permitted. The commercial operation would also require a NPDES permit.⁶ Although there may be more dissolved minerals with the deeper fracture system of a commercial facility due to greater temperature of the geothermal fluid, those constituents will be regulated by a NPDES permit and can be removed as necessary by a waste water treatment facility.¹ If steam generation is selected for the generation facility, the waste water treatment

facility must be adequate to treat cooling tower and blowdown discharges to applicable NPDES limits.⁶

Noise impacts will occur during construction and operation of the facility. The plant site is currently impacted by noise from the present LANL drilling operation and the USFS helicopter landing facility adjacent to the property. Construction noise levels will be of a temporary nature and will probably not have any greater impact than existing noise from drilling operations. In all probability, the operational noises associated with commercial operations will be less than that associated with drilling. Property line noises should therefore be reduced with the start of commercial operations. In addition, much of LANL current operation is located out of doors which increases ambient noise levels. The commercial facility will have most of its operations indoors which will provide some noise attenuation. This, again, should result in lower ambient noise impacts. Present property line noises are less than 70dB(a) due to the heat exchangers. This noise level decreases to background levels at 1/2 mile from the site.¹

LANL noise studies to date indicate no adverse impact to wildlife due to noise from the project. There are no residential areas presently existing or planned near the site. The nearest residence is 1 1/2 miles away. Therefore, adverse noise impacts on residential areas should not be a problem.¹ There are no noise limits or permit requirements applicable to this project.⁷

Radiation and hazardous waste should not present significant problems relating to an HDR commercial facility. Radon gas has been found to accumulate in the geothermal fluid from the rock reservoir. Levels measured are very low, 3 nano curies per liter (nci/l), with a projected maximum concentration of 11nci/l at equilibrium. Ambient air emissions would occur during venting at

the rate of .01 ci/day. This emission will result in annual average concentration which is well within the state's Radiation Protection Regulation limits found in Section 4-160A Appendix A, Table II. It is noted that the amount of radon in the maximum projected release would be equivalent to the radon released from natural soils covering an area of 62 acres.¹ No permits regarding radiation would be required of the project.⁸

As presently proposed, the commercial HDR facility should produce no waste covered by the federal Resource Conservation Recovery Act (RCRA). If this situation changes, numerous solid waste disposal techniques exist that would allow adequate disposal. This is not seen as a significant problem.

Flora and Fauna

The ecological balance at the site was dramatically changed by a large fire in 1971 which destroyed much of the climax vegetation system of spruce-fir (upper elevation) and ponderosa pine (lower elevations). Aerial seeding and planting of ponderosa pines on the burned area has given rise to two additional community types, grass-forb community and Aspen community.¹

It is anticipated that the commercial HDR facility will require 17 acres to adequately place all required facilities and the impacts would not extend beyond the current area of activity. Other impacts will result if additional right-of-way is necessary to transmit power out of the site. Environmental analysis and mitigation requirements associated with building new transmission facilities would assure that no significant adverse impacts to critical habitats would occur.

Impacts to animal populations as a result of commercial HDR construction or operation will be insignificant. Preliminary studies by LANL indicate activities associated with their experimental project has very limited impact

on animal populations. No known habitats of threatened or endangered species were found impacted or destroyed by the project.¹ Since a commercial HDR facility would utilize the same physical property as the LANL project, no significant adverse impacts to local animal populations are expected. If additional transmission facilities are required, some habitat may be altered, due to increased right-of-way needs. It is felt that any adverse impact would be mitigated to an insignificant level by accepted mitigation methods employed in the environmental analysis process associated with new transmission facilities.¹⁰

Social & Economic Impacts

Other geothermal projects exist in the Jemez area. The largest is the Baca Hydrothermal Project being developed by Union Oil, PNM and DOE. Construction and development of Baca and the Fenton Hill HDR project have resulted in a mild acceleration of growth at two nearby villages, La Cueva and Jemez Springs. Jemez Springs, located 12 km (8 mi) south of the project site, has a population of 500 while La Cueva is 2.4 km (1.5 mi) south and has a population of 50. The population of La Cueva and Jemez Springs periodically experience temporary growth from drilling crews working at either Fenton Hill or Baca. To date, these increases have not caused the "Boom Town" problems experienced at other much larger development areas.¹ Due to the small size of a potential commercial HDR facility, it is felt the population fluctuations in the area, due to construction crews would be partially offset by decreases in LANL construction crews. No adverse social or economic problems are foreseen based on previous experience at La Cueva and Jemez Springs; and it is likely minor beneficial economic growth will result.

FUTURE ENVIRONMENTAL STUDY REQUIREMENTS

Pursuant to the requirements of NEPA, a detailed environmental analysis of the project (plant and transmission facilities) are required. The analysis process will be under the direction of a federal lead agency. Other federal agencies may also participate. The federal lead agency is normally chosen by mutual agreement of all federal agencies which have involvement in the project. In most cases, the agency with the greatest involvement (i.e., financial) will become the lead agency. If, for example, the REA supplies the loan guarantees for the project, it would likely be the lead agency and would prepare the environmental reports and determinations under NEPA.¹⁰ The environmental analysis must cover the entire project, including generation and transmission facilities. Based on the analysis, the federal lead agency will develop an environmental assessment evaluating the impact of the project. Due to the small size of the project and the extensive work done by LANL, the cost of the environmental analysis on this project should run no more than \$80,000 to \$100,000 in 1981 dollars.

CONCLUSIONS AND RECOMMENDATIONS

Review of available environmental data indicates minimal adverse environmental impact from any proposed HDR commercial generating facility. The greatest impact would occur from disruption of flora and fauna related to construction of transmission facilities to service the project. Other areas of impact concern pollutants in water discharges from the reservoir and boiler blow down if steam generation is employed. However, this water will be treated to meet NPDES standards prior to discharge or eliminated on site by use of an evaporation pond, and should have little adverse impact. Some concerns have

been expressed related to thermal plume impacts on tree transpiration rates during the winter, and possible damage to nearby trees. If this is the case, it would be very localized and have minor impact. Noise impacts will be minimal as will air impacts. Based on data available, there appears to be no environmental concerns or constraints that should prevent the construction and successful operation of a commercial HDR generating facility.

The NEPA requirements will be met and a detailed environmental analysis carried out if required. If REA is the major funding agency then they will most likely be the environmental lead agency. Under present conditions 15 to 18 months should be allowed for the REA environmental process. However intense public opposition may cause REA to require a full EIS under the NEPA process. This would add 6 to 8 months to the environmental process.

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GOVERNMENT AND COMMUNITY INSTITUTIONAL FACTORS

METHODOLOGY

The methodology used for the study of government and community institutional factors is as follows: An effort was made to inform all interested persons about the HDR study. To provide this information, handouts were written, reproduced, and distributed. Staff attended various public meetings to inform interested parties of the HDR program and studies. Lists of contacts were drafted. Appointments were made to describe the project and to acquire information on issues and concerns.

Approximately 250 handouts were distributed to Pueblos, State and federal agencies, environmental and public interest organizations, and local government officials of municipalities and county government.

Meetings with interested persons and groups were held. The HDR project was outlined during the meetings, and questions and answers were exchanged. Persons were asked to contact the study team if there were further questions or concerns. People and groups were also informed that the study team desired to remain in contact with them and to keep everyone current on project developments.

The basic objectives of this section were to inform persons of the project and to acquire information about concerns and issues. It was designed to assure people that their concerns would be given full consideration and that they would be kept current of any progress on the project.

FEDERAL ROLE

This discussion, on the federal role in HDR, is limited to the federal perception and reaction to the project. Permitting, leasing, and regulatory matters are discussed in other sections of this report. Those federal agencies that the study team met with are: BLM, USFS, DOE, and LANL (not a federal agency).

Generally speaking, the federal government has been supportive of the HDR concept through funding and the general promotion of geothermal energy development. Evidence of this is found in the program of geothermal research and development that DOE has been pursuing. DOE has been promoting research and development efforts as well as commercialization of new technology since its beginning. Since 1970, the LANL has been researching HDR at Fenton Hill and the DOE has been supportive of requests for funds to study the feasibility of electric power generation at the site. The DOE and the REA both have loan programs to support studies and construction of geothermal projects.

Federal budget cuts, if realized, are expected to be significant for the operations of the DOE. The HDR budget requests for Fiscal Year 1982 will probably be reduced by several million dollars¹. Added to the HDR budget will be other funds contributed by West Germany and Japan. These cuts would mean significant changes in the HDR program. There may be no loan guarantee programs or DOE money for commercial development of HDR. The research program, however, should continue at Fenton Hill and the reservoirs should be completed by 1982.

The USFS and BLM should experience similar budget cuts. Budget cuts could result in delays in issuing leases and may result in turning potential developers to other sources of power production. It has been reported ²

that lease processing by the BLM averages just under 2 years throughout the United States and only 18 percent of the applicants over the last 6 years have received leases. The USFS averages about 2.1 years and only 2 percent of all applicants have received leases.

Those federal agencies who were contacted all expressed their desire to help in the commercial development of HDR by carrying out the necessary leasing or regulatory requirements of their agencies, but this is no guarantee of positive results.

STATE ROLE

A broad range of state agencies were visited regarding the HDR project. Agencies visited ranged from the Environmental Improvement Division (EID) to the State Planning Division (SPD).

State agencies were found to be generally in support of the HDR concept. It is important for a developer of HDR to establish and maintain good working relationships with the Department of Natural Resources (DNR) and the Game and Fish Department. Personnel in these departments expressed interest³ in obtaining early information on project development and transmission line activities so that they might have ample time for recommendations concerning rare and endangered species as well as economic game species. These agencies would also be able to assist in any environmental studies that would be required regarding HDR. Impacts of federal funding cuts may be minimal with these departments.

The EMD has regulatory authority regarding HDR through the Oil Conservation Division. It will be important to keep the EMD informed as to HDR progress.

EID of the Department of Health and Environment will play a key role in regulatory matters regarding HDR. It is integrally connected with federal environmental programs and could be significantly influenced by funding changes at the federal level. Those changes could slow the process of permitting and review of environmental documents.

The State Planning Division of the Department of Finance and Administration, coordinates activities of state agencies and carries out reviews on environmental reports and statements. It is responsible for final comments on the part of state government and therefore should be informed of the progress on HDR.

LOCAL GOVERNMENT ROLE

An important sector of government contacted in this study was local government. This includes county and municipal government in the general area of the HDR project.

The Mayor of Jemez Springs was contacted in mid-February. A presentation was also made to the Cuba City Council. Informational material was given to community officials and they were invited to provide comments.

In early March, a presentation was made to the Sandoval County Commission. The Commission expressed several concerns and made suggestions for development of HDR.

ENVIRONMENTAL AND ORGANIZATION RESPONSE

In an effort to determine the concerns of environmental groups, contact was made with the Southwest Regional Director of the Sierra Club in March, 1981. Handouts were provided to the organization and limited discussion held.

The Southwest Research and Information Center was contacted regarding the HDR project. They requested 10 copies of the handout information to be distributed to various environmental groups and interested persons. The Center agreed to organize a meeting wherein issues could be discussed concerning HDR. Basic issues identified during the first contact with the Center included the following:

1. Pueblo Religion	4. Environmental Impacts
2. Water Issues	5. Export of Electricity
3. Recreation Impacts	6. Ultimate Development of Jemez Mts.

Through the discussions with environmental groups there were many instances where there was confusion between the technology of HDR and the technology of the nearby Baca Geothermal development. At times the Baca and HDR projects were considered one and the same. With this lack of distinction, it was difficult to focus on issues that were relevant to HDR.

From the conversations with various environmental groups and organizations, it appears that HDR is not well known as a technology but, based on what is known about it, it is not considered an environmentally unsound method of utilizing heat energy. There is a possibility that HDR would be a reasonably acceptable project to most persons concerned if it were not for the nearby Baca project and the potential for other geothermal development throughout the Jemez Mountain area.

INDIAN COMMUNITY RESPONSE

The response of the Pueblo Indian Community could be the major institutional factor which will have a profound influence on the viability

of HDR. All pueblos in the vicinity of the HDR project were contacted. An additional effort was made to study the religious significance of the Jemez Mountains and to review the experience of the nearby Baca geothermal project.

The first Pueblo met with was Zia. The basics of HDR were explained to the Governor and information packets were left with him which described the project. Water was the major issue identified by Zia Pueblo regarding the HDR project.

Plains met with San Ildefonso Pueblo in late February. The HDR project was discussed and information packets left for review. The Pueblo had one major concern and that was water.

On March 2, 1981, Plains met with Jemez Pueblo officials to explain the HDR project and solicit issues and concerns about the project. The Pueblo officials were well informed about HDR and expressed concerns about water and the impact on Indian culture.

Plains met with San Juan Pueblo and explained the HDR project. The Pueblo officers were interested in the project and were given information packets. The issues of concern were water and the economics of developing power in New Mexico and exporting it to some other state.

Plains met with Santa Ana Pueblo in late February and explained the HDR project. Santa Ana had no comment other than they would review the information packets.

On March 10, 1981, a meeting was held with Santa Clara Pueblo officials. The Santa Clara Pueblo is opposed to any geothermal development in the Jemez Mountains.

The Pueblo officials expressed a broad range of concerns including power lines, water, major geothermal development in the area, pollution, and culture.

In addition to the pueblos mentioned above, San Felipe, Santo Domingo, and Cochiti Pueblos were mailed information packets with requests that they contact the study coordinator if there were questions or if they had any concerns about the project.

It is worthwhile to also mention the three actions that Santa Clara and the other Pueblos are currently involved with. The outcome of these cases will undoubtedly have a major impact on the successful development of the HDR project. The three actions are: The Pueblo suit to issue an injunction against DOE to stop actions and development on the nearby Baca project which the Pueblo alleges would infringe on Indian religious freedom; the pending PNM application to the issuance by the NMPSC of the Certificate of Public Convenience and Necessity for the Baca Project; and the appeal in District Court of the State Engineer's acceptance of Union Oil's application to withdraw certain irrigated crop lands to offset surface flow reductions in the Jemez River.

The injunctive relief being sought by the Pueblos includes: restraining DOE from funding or encouraging the geothermal development of the Baca location until or unless a land use plan is formulated and accepted by all parties and that the plan must protect religious shrines, guarantee unrestrained access to the shrines, and guarantee secrecy and privacy to the plaintiffs.

The NMPSC hearings on the Baca geothermal project for the Certificate of Public Convenience and Necessity were completed in December of 1980. During those hearings the New Mexico Public Service Commission accepted testimony regarding the religious significance of the Jemez Mountains and the impact of the proposed facility on the religious life of the New Mexico Pueblo Indian Community. A decision concerning the permit has been deferred at PNM's request.

Without going into detail on the consensus expressed by the Pueblos regarding HDR, it appears that most of the concerns can be successfully addressed in future impact analyses. The final study regarding the site should evaluate all concerns to assure that questions are fully answered.

Because of the emphasis placed upon religious freedom of the Pueblo Indians and because of Pueblo concerns regarding the religious significance of the Jemez Mountains, an effort was made to identify whether sites and locations within the mountains were considered sacred. An effort was also made to determine Indian use of the Jemez Mountains for religious purposes.

After examining the Fenton Hill HDR site and the Jemez area in general, potential sites of religious significance were plotted. Known sites of religious significance from the New Mexico Laboratory of Anthropology were also mapped. See Figure 8. The result of this effort shows a general pattern of significant sites. The Rio Grande Valley and Pajarito Plateau show high concentrations of sites continuing on down to the confluence of the Jemez River. Also, sites follow the northward course of the Jemez River and form a partial loop around the Valles Caldera. There are a few potential sites following the Rio de las Viejas, Guadalupe River and Rio Cebolla, but of such low density to be easily avoided. There appear to be no potential sites in the immediate HDR project area. Most of the country to the west and northwest of the site appear to be free of potential sites.

Areas of potential religious significance seem to be east and south of the Fenton Hill site.

At no point in the literature reviewed could it be determined that the Jemez Mountains as a whole have been considered as a entity of religious

FIGURE 8
AREA OF POTENTIAL RELIGIOUS SITES

significance. Many points are identified that have religious significance within the range of mountains, but not the range itself.

OVERALL INSTITUTIONAL ANALYSIS

Contacts with government, Pueblos, and organizations were made and informational handouts were provided. The responses from most organizations were limited. Follow-up meetings and telephone calls were made to elicit responses. There may be other organizations that should be informed of the HDR concept and study, but under the compressed time frame there is a sufficient sense of institutional concerns.

In discussions with various federal agencies, the overall impression is that HDR is supported in concept, and that persons in those agencies will cooperate as necessary. Upon examination it appears that leasing practices along with budget cuts and regulations will slow any effort to carry out a HDR project.

State agencies were generally supportive of the HDR concept. The EID will play a significant role in evaluating limited environmental impacts of the proposed project. The Game and Fish Departments' Rare and Endangered Species Program will, perhaps, be the second most significant state agency with which a developer must work.

Reasonable contact should be developed with the Governor's Office, Department of Energy and Minerals, and the State Planning Division.

Environmental organizations showed only limited responses when contacted. Primarily, their concerns are directed toward the nearby Baca project. Some comments indicated optimism for HDR. Many environmental groups, however, may oppose the HDR project. Contacts with other organizations reflected similar concerns as those of the environmentalists

primarily water, Indian religion, and development of the Jemez Mountains.

The Indian Community was generally unresponsive or in opposition to geothermal development and they make little distinction between HDR and the nearby Baca project.

In summary, there is a significant amount of opposition to geothermal development in the Jemez Mountains. Though HDR is not the same technology as Baca, HDR, at this point, faces the same development, environmental, and religious concerns that the Baca project faces.

RECOMMENDATIONS AND CONCLUSIONS

There are no simple conclusions regarding the community and institutional factors faced by commercial development of HDR. Active opposition to geothermal development in the Jemez Mountains could stop or delay any attempt to generate commercial electricity utilizing the HDR concept at the Fenton Hill site.

A developer of HDR should pursue meeting with the Indian Pueblos on a regular basis. This may build a relationship where communication is effective, where suspicion is overcome, and enhance Indian involvement in the project.

A good public information program will be required in order to create an understanding regarding HDR.

In summary, the HDR Project should be pursued with patience and with the desire to address significant institutional concerns. HDR technology could offer significant future returns if it can be proven commercially viable.

The institutional concerns, technical analysis, and economic aspects must all be considered when decisions are made regarding the commercial development of the HDR project.

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LEASING, OWNERSHIP, AND MANAGEMENT OF FACILITIES

METHODOLOGY

This portion examines the current ownership and use of the HDR Project site and reviews the statutory and regulatory provisions applicable to the acquisition of this site for use in demonstrating, by commercial operation, the viability of the HDR resource as an energy source.

Documentation of ownership and use of property such as geothermal resources, land surface, and facilities utilized by the HDR was obtained from the DOE, LANL, the BLM, USFS, and the USGS. The material was evaluated to determine its impact on the ultimate acquisition of the HDR site and facility.

Legal research was completed to determine the existing applicable statutory and regulatory authorities governing the leasing of geothermal resources and the use of the surface property of the HDR site. Contacts were made with departments and agencies identified as having responsibility for the leasing of geothermal resources, the operation of such leases, and the use of the surface property. From these contacts, additional resource materials in the nature of orders, cooperative agreements and procedures, memorandums of understanding, guidelines, and manuals were identified and obtained. Attempts were made to identify those facilities on-site or facilities contemplated to be placed on-site prior to any potential transfer from DOE to a commercial developer.

The methods available by which the transfer of these facilities could be accomplished were researched and discussed with appropriate officials of the DOE.

ASSUMPTIONS

For purposes of this section, it is assumed that the proposed project is to be a commercial operation demonstrating the commercial viability of the HDR geothermal resource, but is not necessarily a "demonstration project", as that characterization may have significance under the law.

In assessing the feasibility of this project, the conditions of financing must be viewed in conjunction with the available methods of acquisition of the geothermal resources and the necessary related surface land interest. It has been assumed for purposes of this study that a commercial operation life of thirty years for both the resource and the power generation plant is necessary. Accordingly, any acquisition of the HDR Project site and facilities must be for the same period.

APPLICABLE LAWS FOR GEOTHERMAL DEMONSTRATION PROJECTS

The establishment of projects demonstrating the commercial viability of geothermal resources was authorized in the Geothermal Energy Research, Development and Demonstration Act of 1974,¹ (GEOTHERMAL DEMONSTRATION ACT), which established the Geothermal Energy Coordination and Management Project² and provided that its chairman

. . . may provide for the establishment of one or more demonstration projects utilizing each geothermal resource base involved, which shall include as appropriate, all of the exploration, siting, drilling, pilot plant construction and operation, demonstration plant construction and operation, and other facilities and activities which may be necessary for the generation of electric energy and the utilization of geothermal resource by-products.³

The transfer of research, development, and demonstration functions granted under the GEOTHERMAL DEMONSTRATION ACT was contemplated and provided for within the Act.⁴ Such functions were subsequently transferred to the Energy Research and Development Administration⁵ (ERDA).

The Non-nuclear Energy Research and Development Act of 1974, (NON-NUCLEAR DEVELOPMENT ACT) created within ERDA a research, development, and demonstration program in non-nuclear energy technologies,⁶ and incorporated the program established by the GEOTHERMAL DEMONSTRATION ACT.⁷ Currently, the research, development, and demonstration functions for geothermal energy created by these laws are vested in the Secretary of Energy and have been since their transfer to DOE from ERDA by the Department of Energy Organization Act,⁸ (DOE ACT).

Geothermal Steam Act of 1970

The Geothermal Steam Act of 1970,⁹ (GEOTHERMAL ACT), enacted on December 24, 1970, directs that the Secretary of the Interior "may issue leases for the development and utilization of geothermal steam and associated geothermal resources" on certain federal lands, including national forest lands.¹⁰ Geothermal steam and geothermal resources are defined to include "... heat or other associated energy found in geothermal formations...",¹¹ which would encompass the HDR geothermal resource.

Rights to develop and utilize geothermal resources underlying lands owned by the United States may be acquired solely in accordance with the provisions of the GEOTHERMAL ACT.¹²

The Secretary of the Interior was directed to determine and publish in the Federal Register all lands within any known geothermal resources area (KRGAs) on the effective date of the GEOTHERMAL ACT. He also was to publish his determination of additional lands for inclusion in a KGRA¹³. Pursuant to the GEOTHERMAL ACT.¹⁴, the Secretary of the Interior has prescribed rules and regulations to carry out its provisions.¹⁵ These regulations and other provisions of the GEOTHERMAL ACT are discussed below.

The DOE ACT transferred functions to promulgate certain regulations pertaining to federal leases under the GEOTHERMAL ACT to the Secretary of Energy from the Secretary of the Interior.¹⁶ Regulations prescribed to date by the Secretary of Energy and applicable to this study are general mineral leasing provisions. These regulations describe their purpose, scope, applicability, authority, definitions, effect on existing regulations, and the administrative procedures for their interpretation and rule making.¹⁷

CURRENT STATUS OF PROPERTY

Location

The HDR project is located in Sandoval County, New Mexico.

The surface property being utilized in the HDR Project is designated as Technical Area 57, and is located in Township 19 North, Range 2 East, Section 13, New Mexico Principal Meridian, New Mexico.¹⁸ This property comprises approximately seventeen to twenty acres,¹⁹ and is unsurveyed.

The subsurface property utilized in the HDR Project is located in Township 19 North, Range 2 East, Sections 12 and 13 and portions of Section 1, 2, 11, and 14, and in Township 19 North, Range 3 East, Sections 7 and 18 and portions of Sections 6 and 19, New Mexico Principal Meridian, New Mexico. The subsurface property includes between 3550 and 3600 acres.²⁰

Management and Ownership

BLM records indicate that both the surface and subsurface property are owned by the federal government and are within the Santa Fe National Forest,²¹ and the surface management is under the authority of the USFS.²²

A major portion of the property utilized by the HDR Project is contained within the Baca Location No. 1 Known Geothermal Resources Area, (Baca KGRA). Lands located in Township 19 North, Range 3 East, New Mexico Principal Meridian, were recommended as within the Baca Location No. 1 KGRA on December 24, 1970, the effective date of the GEOTHERMAL ACT.²³ Publication in the Federal Register occurred on April 3, 1971, defining the Baca KGRA and included Township 19 North, Range 3 East (partly unsurveyed), Sections 1 through 36 within that area.²⁴

On July 14, 1975, additional lands were considered and added to the Baca KGRA, including lands within Township 19 North, Range 2 East, Sections 1, 2, 12, and 13.²⁵ Federal Register publication reflected the addition of these lands to the Baca KGRA, effective February 1, 1974.²⁶

Prior to the enactment of the GEOTHERMAL ACT, notice had been published in the Federal Register of an application by BLM to withdraw all public lands which were valuable or prospectively valuable for geothermal steam resources from all appropriations under the public land laws, including the mining and mineral leasing laws.²⁷ This application was subsequently amended, revised,²⁸ and eventually cancelled on June 15, 1976.²⁹ All of Township 19 North, Range 3 East, had been included in this application.³⁰

Interagency Agreement and HDR Project Development

An Interagency Agreement, Contract No. DE-AC32-79AL10000-1, (Agreement DOE/FS) dated January 3, 1979 was made by and between DOE, Los Alamos Area Office and the USFS. In the Agreement DOE/FS, the USFS granted to DOE the right to use the Fenton Hill Site Area as follows:

TA-57 (Fenton Hill Site), an area of approximately twenty surface acres, located as shown on Appendix A, as necessary for access to and construction, placement, maintenance, alteration, repair, operation, or removal of facilities and roads required in connection with the drilling of up to a total of four wellbores, each may be to a depth of approximately 15,000 feet, and conducting investigations of geology, hydrology, heat-flow, seismic activity, fracture dynamics of hydraulic fracturing and thermal stress cracking in crystalline rocks, heat extraction, a pressurized-water circulation experiment from these holes, and other activities related to and associated with the Hot Dry Rock Geothermal Energy Project but excluding the commercial generation of electricity under this agreement.

A subsurface reservoir pool area (Fenton Hill Site Area) of approximately 3,600 acres, located as shown on Appendix G, to be excluded from the Known Geothermal Resource Area leases, for the Hot Dry Rock Geothermal Energy Project, to conduct investigations of hydraulic fracturing, thermal stress cracking in crystalline rocks, heat extraction, temperature draw-down and flow characteristics of the far-field reservoir; and

The right of access to said site.³¹

Activities related to the HDR Project conducted prior to the effective date of Agreement DOE/FS by DOE and its predecessor agencies, the Atomic Energy Commission (AEC) and ERDA, were done under special use permit, dated April 7, 1972, amended on May 5, 1972, from USFS; and Memorandum of Understanding (Contract AP [29-1]-2213), dated November 30, 1973, between DOE and USFS; and Memorandum of Understanding (Contract AT [29-1]-2218), dated March 26, 1973, as amended, between DOE and the USFS.³² Agreement DOE/FS, however, supersedes these permits and contracts as well as all amendments, supplemental agreements, and modifications made to them³³.

Present leasing Availability of the HDR Project Site

On March 21, 1974, the AEC Area Manager requested, by letter, that BLM not issue geothermal leases in the following lands located in Township 19 North, Range 2 East, New Mexico Principal Meridian: South half of Section 12; North half of Section 13; Lots 5, 6, 7, and 8, in Section 13 and the Southeast Quarter of Section 1, until completion of the HDR Project.³⁴

BLM records reflect this request and designate these lands as "NOL" with a reference to 43 CFR 3201.1-2(b)(1) as the basis for this status designation.³⁵ "NOL" is an abbreviation for "Not Open to Lease."³⁶ Code 43 CFR 3201.1-2(b)(1) reads:

"(b) Notwithstanding any other provision in these regulations, geothermal leases shall not be issued for:
(1) Lands which the Secretary has identified or may identify as being necessary to the performance of his or any other Federal officer's authorized functions, and on which geothermal resource development would in his judgment interfere with such functions;"

Subsequently, on June 3, 1978, the AEC request was modified by a DOE letter requesting that geothermal leases not be issued on certain lands until the HDR Project was completed. The lands included within this request are:

Within Township 19 North, Range 2 East, New Mexico
Principal Meridian, New Mexico:

Section 1 : SE/4, S/2 SW/4;
Section 2 : S/2 SW/4;
Section 11 : E/2;
Section 12 : All;
Section 13 : All north of the north boundary of the
Canyon de San Diego Grant;

Section 14 : E/2 north of the north boundary of the
Canyon de San Diego Grant and lands
within Township 19 North, Range 3 East, New
Mexico Principal Meridian:

Within Township 19 North, Range 3 East, New Mexico
Principal Meridian, New Mexico:

Section 6 : S/2;
Section 7 : All;
Section 18 : All north of the north boundary of the
Canyon de San Diego Grant;
Section 19 : All north of the north boundary of the
Canyon de San Diego Grant;³⁷

The lands described in this 1978 request, to the extent that they differ from those lands described in the 1974 request, are not, however, designated "NOL" and reflected as such on BLM records.³⁸

Accordingly, a question is raised whether lands in this request not presently designated "NOL" by BLM do in fact have such status preventing geothermal leasing, notwithstanding this 1978 request. If it is assumed that "NOL" status is achieved only by an actual entry notation of such status on the official records, certain lands for which such status was requested, but not so entered, may be available for lease at this time.

In this regard, the GEOTHERMAL ACT directs a competitive bidding system for the leasing of lands within a KGRA and a non-competitive application system for other lands subject to leasing under the Act.³⁹ Inasmuch as lands, within the 1978 request, situated in Sections 11 and 14, Township 19 North, Range 2 East, are not designated "NOL" on official BLM records, and are not within a KGRA, non-competitive geothermal lease applications could be filed for them if they are, in fact, subject to leasing at this time. Further, lands situated in the S/2 SW/4 of Section 1, S/2 SE/4 of Section 2, and the N/2 of Section 12, Township 19 North, Range 2 East, for which "NOL" status has likewise been requested, but not entered, are within the Baca KGRA

and could be subject to competitive leasing at this time. It is, however, probable that the BLM would administer these lands as though having "NOL" status, regardless of the absence of a "NOL" status notation on its official records.

To reiterate, the HDR site is comprised of KGRA and non-KGRA lands. Some lands in both categories are not designated as "NOL" on official records. Although requests to designate these lands "NOL" are documented, it is possible that leasing could take place.

Prior to the 1974 and the 1978 requests for "NOL" status by DOE and its predecessor, a non-competitive geothermal lease application was filed with BLM, State Office, Santa Fe, New Mexico, on January 29, 1974. This lease application, No. 20635 was subsequently modified and includes application for lands which are currently utilized in the HDR Project situated in Township 19 North, Range 2 East, Sections 11 and 14, New Mexico Principal Meridian. Specifically, this lease application covers within this Township and Range:

Section 11 : All
Section 14 : Lots 3, 5, 6, 7, 8,
 N/2 N/2, SE/4 NE/4

The HDR Project is utilizing within this Township and Range:

Section 11 : E/2; and
Section 14 : E/2 North of the north boundary of the
 Canyon de San Diego Grant.⁴⁰

On March 23, 1981, this lease application was rejected in its entirety by the Acting Chief, Oil and Gas Section, BLM, State Office, Santa Fe, stating that: "The United States does not own the geothermal resources should there be any under the lands included in this application."⁴¹

Additional questions must now be resolved with respect to this lease application and its rejection. For example, does the United States own the geothermal resources in the area utilized by the HDR Project and applied for in this lease application? Preliminary investigation shows that the BLM, in rejecting this lease application, may have relied upon title information records showing that the lands covered by this lease application were acquired lands with the mineral estate in private ownership. Conflicting BLM records apparently show that these lands are public lands, presumably with federal ownership of the mineral estate. If the United States does not own these geothermal resources, has the HDR Project actually extended its subsurface operation onto these lands? If the United States does own the geothermal resources, does this applicant for the geothermal resources lease have any prior claim or preference to a lease of these geothermal resources on the basis of its rejected non-competitive lease application?⁴² These questions should be answered in order to clarify the present ownership and leasing availability status of the geothermal resources involved in the HDR Project.

Status of On-Site Facilities

The existing facilities at Fenton Hill and any facilities added to the project site could be necessary for the commercial demonstration of this resource by a developer conducting the demonstration project. Such facilities are, or would be, owned by the DOE. Ownership and placement on the project site are subject to Agreement DOE/FS which provides that upon its termination, in whole or part, by either agency with sixty (60) days written notice to the other agency,

(a)ll equipment, structures, and improvements affected by such termination shall be removed from National Forest land within one year after such termination, and the site will be left in a condition acceptable to the Forest Service. If a determination is made to leave an affected improvement in place, the DOE, to the extent that it may lawfully do so, will transfer title to said improvement to the Forest Service.⁴³

Accordingly, Agreement DOE/FS provides for the transfer of improvements to the USFS from the DOE upon its termination.

LEASING OF GEOTHERMAL RESOURCES AT THE HDR PROJECT SITE

The GEOTHERMAL ACT is specific. It is the sole method by which rights to develop and utilize geothermal steam and associated geothermal resources underlying lands owned by the United States may be acquired.⁴⁴

Transfer of Existing Agreements

As an aside, attention was previously given to the possible transfer of the Agreement DOE/FS or any property interests granted therein from DOE to the developer eventually demonstrating commercial application of HDR. Such a transfer would avoid the application of the GEOTHERMAL ACT; but, such a transfer does not appear possible, or, if possible, helpful. Under Agreement DOE/FS, the USFS grants to DOE the right to use the surface site, the reservoir pool area, and the right of access to the site. No property interest appears to be given which could be transferred by the DOE. If the property utilized by the HDR Project is under the custody of the Secretary of Energy for development purposes, the authority granted the Secretary in the DOE ACT to permit the use of such facilities by others⁴⁵ may be applicable. Yet, such a permitting method may not be feasible in light of its five year limitation when viewed in

conjunction with the long-term financing and commercialization necessary for a project.

Other constraints exist with any attempted transfer of Agreement DOE/FS to accomplish a transfer of the HDR Project site. Although Agreement DOE/FS does not expressly prohibit transfer, its scope as an Interagency Agreement between two federal agencies may be exceeded by any such attempted transfer. Lastly, even if the Agreement could be transferred, the parties expressly agreed that Agreement DOE/FS "does not provide for the commercial development or the commercial generation of electricity."⁴⁶ Thus, any transfer of Agreement DOE/FS is clearly not helpful in achieving the result reviewed in this segment of this study - the leasing or acquisition of sufficient control of the HDR project site to successfully demonstrate the commercial generation of electricity from the hot dry rock geothermal resource.

In addressing the mechanisms available under the GEOTHERMAL ACT to acquire a lease or other interest sufficient to allow the construction of a power plant on the HDR Project site, the presence of the existing facilities on-site may not be overlooked. Any transfer of these facilities which would be necessary to accomplish the contemplated commercial demonstration by electrical generation from this resource may have to occur as a separate and distinct transaction from the lease or other interest acquisition of the geothermal resources and surface site utilized by this project. Nevertheless, the unique situation of the presence of these facilities on-site of the property is mentioned as possibly affecting the requirements of obtaining or complying with the terms of a geothermal resources lease at the HDR Project site.

The method of acquiring a geothermal lease is set forth in the GEOTHERMAL ACT⁴⁷ and regulations prescribed by the Secretary of the Interior thereunder.⁴⁸

Leasing of Land Within a KGRA

For lands utilized in the HDR Project within a KGRA, leases are acquired by competitive bidding.⁴⁹ Regulations outline the competitive bidding procedure.⁵⁰ Lands within a KGRA may be nominated for lease.⁵¹ If determined that lands should be offered for lease, a notice of lease sale is published.⁵² The contents of notice of lease sale include the time and place of sale, the manner of bidding, a description of the lands, terms and conditions of sale, including royalty and rental rates, the appropriate BLM Office from which to acquire additional information, and the requirement that a proposed plan of operation must be filed before the lease can be issued.⁵³ Bids are sealed and must contain one-fifth of the amount bid. The remaining amount must be paid by single payment or two equal annual installments due on the anniversary date of the lease.⁵⁴ The award of the lease will be made within 30 days or longer, if necessary, after the bids are opened, but the right to reject any and all bids be reserved.⁵⁵

Leasing of Land Outside a KGRA

For lands utilized by the HDR Project not within a KGRA, a non-competitive application system would be utilized.⁵⁶ Regulations outline this procedure,⁵⁷ and require the filing of an application in a form approved by the Director of BLM Office having jurisdiction over the lands; in this case, the State Office in Santa Fe, New Mexico.⁵⁸

General Information on Leasing

With respect to both the competitive bid and non-competitive leasing methods, the issuing of leases is discretionary and, accordingly, may be denied.⁵⁹ Since the HDR Project site is located upon national forest lands, although geothermal leases may be issued for such lands,⁶⁰ leases for lands administered by the USFS may only be issued with the consent and upon such terms as prescribed by the Secretary of Agriculture.⁶¹

In this regard, an Environmental Statement prepared for geothermal leasing in the Santa Fe National Forest⁶² is utilized as the basis for determinations by the USFS whether to consent to leasing in that Forest.⁶³ The HDR Project site is designated in this statement as a no-lease area because of heavy recreation use and high scenic quality.⁶⁴ Accordingly, under present practice, consent to a geothermal lease of the HDR Project site may not be given by the USFS. The existing development at this site, with USFS Agreement, may, however, provide a basis for an exception to this policy.⁶⁵

At the present time, leasing of lands utilized by the HDR Project may not be possible under the leasing prohibition of 43 CFR 3201.1-2(b)(1) as discussed above. Before these lands could be leased, the request of DOE for "NOL" status on these lands would have to be lifted. There is not a prescribed method by which "NOL" status is imposed or removed from lands subject to leasing under the GEOTHERMAL ACT. Query, can the removal of such status on the lands involved in the HDR project be informal as was the imposition of such status, i.e., by letter request?

Geothermal leases have a primary term of ten years, but shall continue for an additional term of not to exceed forty years so long as geothermal steam

is produced or utilized in commercial quantities.⁶⁶ Thereafter a preferential right for an additional forty year term exists if the land is not needed for another purpose and production of geothermal steam is produced or utilized in commercial quantities.⁶⁷

"Production or utilization of geothermal steam in commercial quantities" includes completion of one or more wells producing or capable of producing geothermal steam in commercial quantities and a bona fide sale of such for delivery or utilization by a facility scheduled for installation not later than fifteen years from the date of commencement of the primary term of the lease.⁶⁸

Geothermal leases are limited to an acreage maximum of 2,560 acres each, with a statewide limit of all interests, direct or indirect, in federal geothermal leases of 20,480 acres.⁶⁹ The individual lease maximum of 2,560 acres may be of concern in light of the current HDR Project's utilization of 3,550 to 3,600 acres.

Geothermal leases may only be issued to citizens of the United States, associations of citizens or coporations organized under the laws of the United States, or governmental units.⁷⁰ Each applicant for a lease must file a statement of citizenship and a statement that his interests in federal geothermal leases in the state do not exceed the statewide acreage limitation.⁷¹ All applications and nominations for lease must include a description of the lands to be included.⁷²

Possible constraints upon the scheduling of power and energy could result from the applicant requirements for the suspension of operation on a geothermal lease.⁷³

Filing Fees and Royalties

There is no service charge for filing competitive applications or nominations; non-competitive applications and assignments require a \$50.00 service charge.⁷⁴

Geothermal leases shall provide for:

an annual rental of not less than \$1.00 per acre;

a royalty of not less than 10 percent or more than 15 percent of the amount or value of the resource derived from production and sold or utilized by the lessee or susceptible of such sale or utilization;

a royalty of not more than 5 percent of any by-product value derived from production, with certain exceptions; and

a minimum royalty, in lieu of rental for producing leases of \$2.00 per acre.⁷⁵

Rentals are increased in this sixth year of the lease by \$1.00 per acre over the preceding year's rental until production in commercial quantities on the lease has occurred.⁷⁶

The appropriate royalty set out in the lease is applied to the value of geothermal resources and by-products.⁷⁷ The value of the geothermal resources is determined by the USGS. For power plant production from geothermal resources, the value shall be no less than the value of the end product attributable to the geothermal resources utilized directly in power production.⁷⁸

Royalties and rentals may be adjusted at not less than 20 year intervals beginning 35 years after the date geothermal steam is produced, but not increased more than 50 percent. Under no circumstances shall the royalty

exceed 22½ percent. Provision for such readjustment will be included in each lease.⁷⁹ The waiver, suspension, or reduction of rentals and royalties may be allowed,⁸⁰ but not where the only reason for a request for such relief is the unavailability of a power generating facility to utilize the geothermal resource.⁸¹

The first year's rental of \$1.00 per acre must be included with each application; if the annual rental is more, the additional rental must be paid before the lease is issued.⁸²

Readjustment of any other terms and conditions of the lease may occur at not less than 10 year intervals beginning 10 years after the geothermal resource is produced and utilized for any purpose including the generation of electricity.⁸³

Certain bonds are required for geothermal leases, including a lease compliance bond and a protection bond.⁸⁴

Assignment of Lease

An alternative method for a developer to obtain a geothermal resources lease, at the HDR Project site, is to obtain an assignment from the lessee holding such a geothermal lease. Procedures for assigning a geothermal lease are set forth in the GEOTHERMAL ACT regulations.⁸⁵ An application requesting approval of any assignment must be filed in the BLM office having jurisdiction over lands involved, with a \$50.00 application fee.⁸⁶ The application must be filed within 90 days from the execution of the assignment. It must contain all terms and conditions agreed to by the parties.⁸⁷ It must be on an approved form,⁸⁸ and describe the lands involved.⁸⁹ The assignee must be qualified to take and hold the lease, file a statement of interest relative to the acreage

limitation holdings,⁹⁰ and file a required bond⁹¹. Requests for approval of assignment will be reviewed to adjust environmental terms and conditions, prior to approval.⁹² Upon approval, the assignee and his surety will be responsible for lease obligations in spite of any terms in the assignment to the contrary.⁹³

Licenses

A license is to be applied for to utilize federal lands under a geothermal lease by persons who have acquired the production of geothermal steam and resources for the purpose of generating electric power.⁹⁴ Rights to use lands under a geothermal lease for generating electricity must be acquired and exercised in accordance with these regulations.⁹⁵ A lessee or party to a joint utilization agreement or sales contract who has a producible well and desires a license to use the surface of lands under a federal geothermal lease for construction of an electric generating plant shall file an application for a license⁹⁶ with the authorized BLM Officer.⁹⁷

Licenses are not required for a Research and Demonstration project,⁹⁸ an Individual Well Production utilization,⁹⁹ or a Plant Facility proposed to have an output of 20 megawatts net capacity or less.¹⁰⁰

A Research and Demonstration Facility is defined as a facility located on a federal geothermal lease which utilizes geothermal resources from one or more wells, has an output of 20 megawatts net capacity, and will be utilized exclusively for research and demonstration of applications for the utilization of geothermal resources during an initial project life of not to exceed five years from the date the facility becomes operational.¹⁰¹ A license for a

Research and Demonstration facility will, however, be required after the initial five year project period.¹⁰² The power plant to be located at the HDR Project site is to demonstrate commercial viability by commercial operation. Thus, such a power plant would not qualify as a Research and Demonstration project, inasmuch as it would not be exclusively for research and demonstration.

An Individual Well Production facility is defined as a facility located on a federal geothermal lease that utilizes geothermal resources from a single well and has an output of no more than 10 megawatts net capacity.¹⁰³ Whether the proposed power plant is such a facility thereby not requiring a license will be determined by the meaning of the terms "single well". It appears that the definition of this facility is not designed to cover the HDR operational concept whereby a dual system of wells is utilized. If the proposed facility is determined to be utilizing geothermal resources from a single well, the facility would be an Individual Well Production facility inasmuch as 10 megawatts net capacity is projected as its maximum output, and would not require a license under this allowable exception.

The regulations describing the exception to this license requirement for a Plant Facility¹⁰⁴ with a proposed output of 20 megawatts or less net capacity are unclear. The BLM regulations make no express provision for this exception and, in fact, require a license for a substation or facility for transmission or lease of more than 10 megawatts maximum output.¹⁰⁵ The USGS regulations pertaining to the operations of geothermal resources leases, ¹⁰⁶ however, require a license for a Plant Facility with a proposed output of greater than 20 megawatts net capacity.¹⁰⁷ Thus, it appears unclear whether a Plant Facility with an output of 20 megawatts or less net capacity requires a license. Since the power plant reviewed in this study would apparently

be a Plant Facility, if not an Individual Well Production Facility, this regulatory inconsistency should be resolved.

A license application, with a \$50.00 fee, shall be filed containing a description of the lands applied for, a map indicating boundaries and proposed facility locations, as well as a power plant description and any joint utilization or sales contracts made with the federal geothermal lessee. It must also contain the amount of timber, if any, which would be destroyed in the construction of the proposed plant, and a statement of agreement to deposit the stumpage value of the timber to be destroyed.¹⁰⁸ Citizenship is required as is evidence of corporate status and authorization, if applicable.¹⁰⁹

An environmental analysis will be conducted for the license application and include an analysis sufficient to determine whether an environmental impact statement is necessary.¹¹⁰

A proposed power plant on the HDR Project site would be subject to the agreement of the USFS regarding specific site selection and the license would include terms and conditions required by the USFS.¹¹¹

No license may be issued for lands on which geothermal leases may not be issued.¹¹² A license is for a primary term of 30 years with preferential renewal, and shall contain terms necessary to protect the mineral, environmental, and public land values, as well as require a utility commission license prior to any activity relating to plant operation.¹¹³

The annual rental for the license shall be not less than \$100.00 per acre as assessed by the authorized BLM officer and may be reassessed every ten years, excluding improvements added for the utilization of the geothermal resources.¹¹⁴ As with leases, bonds are required¹¹⁵ and assignments allowed upon approval.¹¹⁶

Upon expiration, termination, or relinquishment of the license, the structures must be removed at the cost of the licensee and license reclamation requirements satisfied.¹¹⁷

Other Leasing Concerns

Competitive bidding for KGRA lands, which comprise the majority of the HDR Project site, could be a constraint upon the involvement of rural electric cooperatives or developers made up of rural electric cooperatives. The front-end money needed for the cash bonus required to be submitted with the bid may be unavailable to them.¹¹⁸ S.669, 97th Congress, First Session, contains a provision to allow a percentage of leasing tracts in each year to be offered on the basis of specific non-competitive application by public bodies, including rural electric cooperatives or non-profit corporations controlled by and predominantly made up of such entities.¹¹⁹ Any constraint which may exist with competitive bidding by electric cooperatives could be eased by this legislation. A similar provision was contained in S. 1388, 96th Congress, Second Session.¹²⁰

In both the GEOTHERMAL ACT and its regulations, the words "geothermal steam" are often used instead of "geothermal steam and associated geothermal resources", as defined in the Act or "geothermal resources" as defined by the regulations to include "heat or other associated energy found in geothermal formations".¹²¹ The HDR resource is heat, not steam, and accordingly, confusion may result regarding the extension or application of the Act and regulations to the HDR resource because of the absence of a standardized term to describe all geothermal resources.

Provisions in S. 669, 97th Congress, First Session, address and attempt to correct this problem by offered amendments to the GEOTHERMAL ACT.¹²²

Operation of Geothermal Leases

The operations of geothermal leases on federal lands are overseen and supervised in accordance with USGS regulations.¹²³ Requirements under these regulations, for filing plans of development and operations before certain activities may commence on the lease, have not been met for the HDR Project. Whether any lessee of the site would be required to submit after-the-fact" plans, reports or records to the USGS covering earlier activity of the HDR Project is unclear. A description of USGS filing and reporting requirements is contained in the Section entitled "Regulations, Permits and Laws."

A lessee of a geothermal lease is entitled to use as much of the surface land covered by the lease as is necessary for the production, utilization and conservation of the geothermal resources.¹²⁴ Such use would be subject, in this instance, to additional terms and conditions placed on such use by the USFS.¹²⁵ Specific surface use requirements and reports are mandated by the regulations of the Secretary of the Interior pertaining to equal employment opportunity, public access to and upon the leased land, pollution abatement, sanitation and waste disposal, land subsidence, seismic activity, aesthetics, fish and wildlife, antiquities and historical sites, and restoration of the surface.¹²⁶

The GEOTHERMAL ACT provides that it is to be administered under principles of multiple use of land and resources and to the extent feasible, geothermal leases shall allow for other mineral leases.¹²⁷ In addition, the United States reserves the ownership and right to extract oil, hydrocarbon gas, and helium from resources produced from lands leased under the GEOTHERMAL ACT.¹²⁸

In both of these instances, the GEOTHERMAL ACT provides that such other lease or exercise of right of extraction shall not substantially or unreasonably interfere with the production of geothermal resources from such lands.¹²⁹ Notwithstanding this provision, the construction of a power plant and the anticipated conditions placed upon financing such construction, would probably require a much more formal and secure prohibition against all other mineral development on the lands scheduled for construction to avoid subsidence, interference with construction and operation of the power plant as well as any impairment of the reservoir.

In implementing the rules and regulations pertaining to geothermal resources, the USGS, Fish and Wildlife Service, and BLM have entered into a memorandum of understanding for the geothermal program¹³⁰ referred to as the Department of the Interior's Tripartite Agreement. A Geothermal Regulatory Process Chart has been compiled from the GEOTHERMAL ACT regulations and this Tripartite Agreement.¹³¹

In addition, a Cooperative Agreement for the Geothermal Program on National Forest System Lands between the USGS and USFS sets forth the procedures to be followed by these agencies in implementing their responsibilities under the geothermal resources program.¹³²

ACQUISITION OF SURFACE PROPERTY AT HDR SITE

The GEOTHERMAL ACT provides that a lessee may utilize as much of the surface of the leased property as may be necessary for the production, utilization, and conservation of geothermal resources.¹³³ The regulations further provide that a lessee shall have the right to use as much of the surface as is necessary for a power generation plant and may apply for other

federal lands as necessary. Lands within the area of operations, on the lease, are subject to supervision by USGS.

Lands outside of the area of operations are subject to the supervision of the appropriate surface management agency¹³⁴ in this instance, USFS. As previously discussed, terms and conditions as required by the USFS are to be included in both the geothermal resource lease¹³⁵ and license, if required.¹³⁶

For any other use of the surface property at the HDR Project site, application would have to be made to the Forest Service. As explained in the Forest Service Manual, the geothermal resources lease grants a right to use the surface for the production of the resource. This includes construction of structures or other improvements for the operations of the lease.¹³⁷ No right is granted under a lease for non-lease uses or for uses of any surface property other than the surface property of the lease. A special use permit must be obtained for such purposes.¹³⁸

Special use authorizations, formerly, special use permits, on USFS lands may be obtained in accordance with regulatory procedures.¹³⁹ Special use authorizations may be either for an easement, lease, permit, or term permit.¹⁴⁰ Pre-application contact is encouraged to provide the opportunity to identify potential restraints and land use conflicts as well as to schedule the application process.¹⁴¹

Applications are filed with the District Ranger or Forest Supervisor having jurisdiction over the lands. Coordination of other applications is allowed to minimize duplication.¹⁴²

Applications must:

identify the applicant and his technical and financial capability;
describe the project, the lands to be occupied, environmental impacts, including public benefits and safety; as well as,
reveal compliance with existing laws and regulations, an environmental protection plan, and other information as required.¹⁴³

Upon receipt of the application, which will be acknowledged in writing, the authorized officer will assess the applicant's qualifications, complete required environment reviews, determine compliance with other laws, regulations and orders, and consult with other agencies and the public. The officer will hold public meetings if deemed to be warranted to evaluate and decide whether to approve the application and to prescribe the terms and conditions for inclusion in the special use authorization. Notice of the application will be given to federal, state and local governments and the public with an opportunity for them to comment.¹⁴⁴ An easement, lease, or term permit, all of which are special use authorizations, becomes effective when signed by both the applicant and the authorized officer. The regulations do not describe how a permit becomes effective.¹⁴⁵

An application may be denied if the use applied for is incompatible with the land's purpose or use and if the use is not in the public interest. The application may also be denied if the applicant is not qualified, does not have the necessary technical or financial capacity for the project, or if the use sought is inconsistent with federal, state, or local laws.¹⁴⁶

Once granted a special use authorization, its holder may only occupy such land and structures and conduct such activities as are determined to be necessary for the occupation of the facilities authorized, for the

construction, operation, maintenance, and full utilization of the facilities authorized, and to protect the public health and safety and environment as specified in the special use authorization.¹⁴⁷ A special use authorization will contain terms and conditions which will require compliance with existing laws, regulations, and standards, and minimize damage to and protect the interests of governmental and public concerns.¹⁴⁸ In addition, the duration and renewability of the special use authorization will be set out, including provisions for revision of terms and conditions at specified intervals for authorizations exceeding thirty years.¹⁴⁹ Renewal is required if provided for in the special use authorization and authorized by law; otherwise, renewal of a special use authorization is discretionary.¹⁵⁰ Preconstruction approval is required by the USFS on location, plans, and design prior to construction.¹⁵¹

The holder of a special use authorization assumes certain liability for the use of the property and agrees to indemnify the United States for all injuries, loss or damage caused by the holder's use or occupancy.¹⁵² A bond to secure the performance of obligations assumed by the holder in the special use authorization may be required.¹⁵³

Annual rental fees based upon the fair market value of the rights conferred by the special use authorization are required, with specified waiver provisions.¹⁵⁴ Transfer of special use authorizations are allowed upon approval, with certain exceptions.¹⁵⁵ Modification of a special use authorization for any new, changed, or additional use or area requires the filing of a new application.¹⁵⁶

Except for certain easements, a special use authorization may be suspended, revoked, or terminated for non-compliance with its terms or

applicable laws and regulations; for failure to exercise rights granted, by consent of the holder, or by its expressed terms.¹⁵⁷ Upon termination, the holder shall remove the structures and improvements from the site and restore it to a condition satisfactory to the authorized officer, unless waived. Failure to remove the structures and restore the site does not relieve the holder of his liability for removal or restoration costs.¹⁵⁸

ACQUISITION OF FACILITIES

In this segment of the study, authority and methods are examined by which DOE could transfer the facilities and improvements at the HDR Project location to a developer. Attempts were made to obtain an inventory of specific facilities on-site or intended to be included there under the current HDR Project program.¹⁵⁹ These attempts were made in an effort to determine those facilities necessary for use with any proposed power plant to be constructed. Such an inventory or other specific itemization was not obtained.

The facilities and improvements presently on-site and any facilities or improvements intended to be located there under the current HDR Project program may not be utilized for the commercial development of electricity.¹⁶⁰ In addition, the removal of all facilities is required within one year after Agreement DOE/FS terminates. The site must be left in a condition acceptable to USFS, unless a determination is made to leave an improvement in place. If such a determination is made, DOE will transfer title to the improvement to the USFS to the extent such transfer may be lawfully made.¹⁶¹

Although not expressly identified, certain facilities and improvements at the HDR Project site may have become fixtures by their non-severability from

the real property upon or within which they are located. As mentioned above, DOE has no interest in the real property of the HDR Project site by which any fixtures could be transferred. Use of any fixtures, however, may pass with a lease of the HDR Project site or may possibly be permitted by the USFS.

Since the USFS may acquire title to any facilities left on-site, use of such facilities, including those which are fixtures, could possibly be permitted under the terms and conditions included by the USFS within any lease, license or surface use authorization granted for the HDR Project site.

Should DOE wish to transfer the facilities or improvements which are its personal property at the HDR Project location to a developer to utilize in demonstrating the HDR resource, Agreement DOE/FS would have to be amended to allow for such transfer. Amendments of this Agreement DOE/FS may be made only by the Forest Supervisor and DOE Area Manager,¹⁶² the signatories to Agreement DOE/FS.¹⁶³

Although amendments could be made to the current restrictions, future additional restrictions could be made by either subsequent agreement, mineral leasing provisions or otherwise.

As mentioned above, use of geothermal resources and related surface property at the HDR Project are not transferable by DOE. Accordingly, if these facilities are to be used in demonstrating the HDR resources, and such use is assumed, any transfer would need to be to a developer with a geothermal resources lease of the HDR Project area and the requisite authority for the use of the related surface area.

Property disposal by federal agencies is to conform with the directions of the Federal Property and Administrative Services Act of 1949¹⁶⁴ (FPASA). Property disposal regulations have been issued by both the General Services Administration (GSA) for general application¹⁶⁵ and by DOE for its specific property disposal activities.¹⁶⁶ An exception contained in the FPASA, however, provides that nothing in this Act is to impair or affect any authority of the AEC,¹⁶⁷ a predecessor of the current DOE. Regulations set forth the procedure by which this exception may be utilized.¹⁶⁸ Other statutory provisions, however, may have removed the FPASA from application to any transfer of the facilities by DOE.

In the DOE ACT, the Secretary of Energy is authorized to enter into and perform contracts, leases, cooperative agreements or other similar agreements with private organizations and persons, and make payments as deemed necessary by him to carry out his functions.¹⁶⁹ This authority is only effective to the extent and in the amounts provided in advance in appropriation acts.¹⁷⁰

Cooperative agreements with utilities and other non-federal entities for the construction of facilities to produce energy for commercial disposition are authorized by the GEOTHERMAL DEMONSTRATION ACT,¹⁷¹ the authority for which is vested in the Secretary of Energy.¹⁷² Under the GEOTHERMAL DEMONSTRATION ACT, authorization is given to establish one or more demonstration projects for each geothermal resource base;¹⁷³ the HDR resource, however, may not be included. The definition, in the GEOTHERMAL DEMONSTRATION ACT, of "geothermal resources" does not include heat or any other reference expressly encompassing the hot dry rock geothermal resource.¹⁷⁴

Federal assistance is also authorized in the NON-NUCLEAR DEVELOPMENT ACT,¹⁷⁵ as well as authority to enter into cooperative agreements with non-federal entities to demonstrate, on a full scale or prototype basis, the technical feasibility and economic potential of different energy technologies.¹⁷⁶

The Federal Grant and Cooperative Agreement Act of 1977¹⁷⁷ differentiates between federal assistance and procurement relationships and directs that a grant or cooperative agreement is to be utilized whenever the principal purpose of the relationship is the transfer of money, property or services, or anything of value from the federal government to a recipient to accomplish a public purpose of support or stimulation, authorized by federal statute, rather than acquisition for direct benefit to or use by the federal government.¹⁷⁸ When substantial involvement is anticipated between the federal government and the recipient, a cooperative agreement is to be used.¹⁷⁹

This study reviews the demonstration of the commercial viability of a geothermal resource by the commercial generation of electricity. Such a demonstration appears to be authorized by the GEOTHERMAL DEMONSTRATION ACT¹⁸⁰ and NON-NUCLEAR DEVELOPMENT ACT¹⁸¹.

Accordingly, a grant or cooperative agreement could be utilized as an appropriate assistance instrument, if any, setting forth the terms under which the DOE could participate with a developer in accomplishing this demonstration.

A DOE memorandum, from the office of the Assistant General Counsel for Procurement, discusses these laws and regulations and concludes that the DOE has authority to vest title to its personal property in its cooperative agreement partners, by including such transfer of title in the cooperative

agreement document,¹⁸² and that such transfer is outside the property disposal requirements of the FPASA. Such transfer would reduce, to the extent of the value of the facilities transferred, the federal share of its cost participation in any demonstration project.¹⁸³

This memorandum also makes reference to the Department of Energy Act of 1978, to the effect that it may authorize the vesting of title to personal property in federal grantees.¹⁸⁴

Thus, it would appear that DOE could, by use of a cooperative agreement, transfer those facilities and other improvements, which are personal property at the HDR Project site, by the use of a cooperative agreement. Regulations have been prescribed by DOE relating to the use of federal assistance¹⁸⁵ generally, and the administrative mechanisms governing the use of cooperative agreements¹⁸⁶ specifically.

If any patents have been acquired from the activities and developments of the current HDR Project, the use of which would be necessary for the commercial demonstration, such patents would have to be made available by license or otherwise for such necessary use for the duration of the commercial operation of the project.

RETAINED INTERESTS AT HDR PROJECT SITE

Until 1979, the Department of Energy and its predecessors exclusively supported the HDR Project. In that year, the United States, by DOE, entered into an International Energy Agency Implementing Agreement for a Programme of Research, Development and Demonstration on Hot Dry Rock Technology with the Government of West Germany, (WG Agreement).¹⁸⁷

A similar agreement has recently been entered into by DOE and the Japanese government.¹⁸⁸

In brief, the WG Agreement provides for a cash contribution to the HDR Project by West Germany in an amount equivalent to 25 percent of the annual DOE funding of the project, up to 2.5 million dollars annually calculated from October 1, 1971.¹⁸⁹ These contributions are subject to the availability of appropriated funds.¹⁹⁰ In consideration for this contribution, West Germany and DOE will cooperate in exchanging information on the project. In addition, West Germany may assign, at its own cost, three experts for as long as four years to participate in the planning, conduct, and analysis of the project. For limited periods of from three to six months, West Germany may also assign a maximum of three additional experts at any one time.¹⁹¹ These experts have the right to participate in meetings of LANL review or planning groups.¹⁹²

All data and information associated with the project shall be available to West Germany and its assigned personnel,¹⁹³ and all reports of joint activities by the United States and West Germany will be published as joint publications.¹⁹⁴ The term of this WG Agreement is for an initial period of four years, but may continue thereafter upon agreement by the parties.¹⁹⁵

The activities included in the project covered by WG Agreement are contained in the Annex to the Agreement. Specific provision in this Annex states that a pilot plant is not included as part of the project covered by WG Agreement. However, WG Agreement does provide that the possible establishment of such a plant will not be hampered or precluded.¹⁹⁶

Accordingly, it does not appear that any interests in the current HDR project would carry over to the construction of a power plant demonstrating the

HDR resource since such a demonstration is outside the project scope of this Agreement. Nevertheless, any continued involvement by the Japanese and West German governments, through DOE, at the HDR Project site, during any construction and operation of a commercial facility would have to be clarified.

Specific interest or activities to be retained by DOE in the HDR Project, should the demonstration of this resource be established, have not been finalized. DOE through LANL would probably wish to remain involved in the demonstration project to the extent of providing technical, engineering and scientific assistance.¹⁹⁷ It may also wish to monitor the facility for continuous data collection and assessment of the resource and operation.

In Appendix F of Agreement DOE/FS, a Deep-Well-Bore Equipment Test Station (DWETS) is contemplated for location at the Fenton Hill Site.¹⁹⁸ The DWETS facility is included as a part of the project covered by the WG Agreement.¹⁹⁹ Although not a part of the project reviewed in this study, any development of DWETS on location at the HDR Project site could create a complication with respect to the authority for management of and access to the site during any construction or operation of a commercial power plant.

CONCLUSIONS AND RECOMMENDATION

The HDR Project site is located on federal lands within the Santa Fe National Forest. Upon the completion of this project, any existing prohibitions or restrictions against the leasing of the geothermal resources developed there would have to be lifted.

Leasing of the geothermal resources could then occur under the provisions of the GEOTHERMAL ACT, which is administered by the Secretary of the Interior. BLM administers the leasing processes of these resources; USGS supervises the operations of these leases.

The HDR Project site contains lands designated as within a KGRA and lands not so designated. Under the GEOTHERMAL ACT, the leasing of KGRA lands is by competitive bid; other lands may be leased by non-competitive application. The offering of competitive bid leasing on KGRA lands and the granting of both competitive and non-competitive leases are discretionary with the Secretary of the Interior. Accordingly, even though leasing of the HDR Project site may no longer be prohibited, the leasing of any of its lands may not necessarily be offered or granted.

Regulations promulgated under the GEOTHERMAL ACT set out the specific procedural requirements for obtaining competitive and non-competitive geothermal leases and the substantive terms and conditions to be contained in all geothermal leases. The procedural process for obtaining geothermal leases reveals no constraints on the development of this project. Substantively, however, the limitation of 2,560 acres per lease, the administration of leases under the principles of multiple-use, the uncertainty of royalty computation and the procedural requirements for obtaining a suspension of operations on a geothermal lease raise certain questions.

Evident throughout this review is the extensive authority and involvement of the USFS in the leasing and development of geothermal resources. A lease of the HDR Project site, which is located on Forest Service land, would require the consent of USFS.

In this regard, USFS, based upon its current policies and practices, would probably not consent to a lease of this area. Further, as the surface management authority for the leasing of the lands of the HDR Project site, USFS may include terms and conditions upon the use of the surface area in both the leases of geothermal resources and licenses for power plant construction. In addition, USFS agreement is required for site selection of any power plant license. Lastly, any non-lease uses or off-lease uses of surface property for the development of this project would require special use authorizations from USFS.

Certain facilities of the HDR Project would be needed by a developer. Under Agreement DOE/FS, these facilities are to be transferred to USFS to the extent legally possible, upon termination of Agreement DOE/FS.

It appears that USFS could authorize the use of these facilities, or if DOE retained them, that it could do likewise. If DOE could retain these facilities, its authority to enter into cooperative agreements for the demonstration of energy technologies, may provide a mechanism by which these facilities could be transferred to a developer.

Notwithstanding the availability of leasing procedures and authorities by which the HDR Project facilities could be obtained, the most obvious constraint is the uncertainty of acquisition by one developer of the entire project. Since both the competitive and the non-competitive leasing systems would be required, an applicant for a lease could acquire only a portion of the site. A transfer of the facilities or other method by which sufficient use of the facilities could be acquired may be required distinct from the geothermal resources leasing process.

A one-step, streamlined, non-competitive transfer method by which all property and other rights necessary to demonstrate the commercial viability of the HDR resource should be fashioned. Such a method would avoid the potential uncertainty of acquisition and allow for the necessary interests to be acquired by a developer willing and capable of accomplishing the demonstration. This method should provide for a transfer to a utility-type organization, capable and qualified to construct and operate the facility, and which is already providing bulk power deliveries in the area and is certified by NMPSC for such a purpose.

Should it be determined that special legislation is required to allow for such a method of transfer to accomplish this commercial demonstration, it would obviously be advisable to review and resolve any other identified constraints, if possible, which would render this project unfeasible within the same legislation.

REFERENCES

1. P.L. 93-410, Title I, §105, (Sept. 3, 1974), 88 Stat. 1084;
P.L. 95-238, Title V, §504, (Feb. 25, 1978), 92 Stat. 86; 30 USC 1125
2. P.L. 93-410, Title I, §101, (Sept. 3, 1974), 88 Stat. 1080;
P.L. 95-238, Title V, §502 (Feb. 25, 1978), 92 Stat. 86;
30 USC §1121
3. P.L. 93-410, Title I, §105(b), (Sept. 3, 1974), 88 Stat.
1084(b); 30 USC §1125(b)
4. P.L. 93-410, Title III, §303, (Sept. 3, 1974), 80 Stat. 1088;
30 USC §1163
5. P.L. 93-438, Title I, §103 (Oct. 11, 1974), 88 Stat. 1235;
42 USC §5813; E.O. No. 11834 (January 15, 1975)
6. P.L. 93-577, (Dec. 31, 1974), 88 Stat. 1879; 42 USC 5901,
et seq.
7. P.L. 93-577, § 3, (Dec. 31, 1974), 88 Stat. 1879; 42 USC §5902
8. P.L. 95-91, Title III, §301, (Aug. 4, 1977), 91 Stat. 565,
577; 42 USC §7151
9. P.L. 91-581, (Dec. 24, 1970), 84 Stat. 1566; 30 USC §1001,
et seq.
10. P.L. 91-581, § 3 (Dec. 24, 1970), 84 Stat. 1566; 30 USC §1002
11. P.L. 91-581, § 2 (Dec. 24, 1970), 84 Stat. 1566; 30 USC §1001
12. P.L. 91-581, §23 (Dec. 24, 1970), 84 Stat. 1573; 30 USC §1022
13. P.L. 91-581, §21 (Dec. 24, 1970), 84 Stat. 1572; 30 USC §1020(a)
14. P.L. 91-581, §24 (Dec. 24, 1970), 84 Stat. 1573; 30 USC §1023
15. Title 30, Chapter II of the Code of Federal Regulations,
Parts 270 and 271; Title 43, Chapter II of the Code of
Federal Regulations, Parts 3000, 3200, 3210, 3220, 3230,
3240, and 3250

16. P.L. 95-91, Title III, §302, (August 4, 1977), 91 Stat. 578; 42 USC §7152(b). For the administration of these leasing function transfers, see: P.L. 95-91, Title III §303, (August 4, 1977), 91 Stat. 579; 42 USC §7153
17. Title 10, Chapter II of the Code of Federal Regulations, Subchapter C, Part 375, Subpart A -- General Provisions, 45 F.R. 9530 (Feb. 12, 1980)
18. HOT DRY ROCK GEOTHERMAL ENERGY PROJECT, Drawing No. 81Y210193, dated 2/1/78, Los Alamos Scientific Laboratory (hereinafter Drawing No. 81Y210193, dated 2/1/78)
19. Interagency Agreement, Contract No. DE-AC32-79AL10001, dated January 3, 1979, between the United States Department of Energy, Los Alamos Area Office, and the United States Department of Agriculture, Forest Service, (hereinafter Agreement DOE/FS) p.4.
20. Agreement DOE/FS p.4.
21. Township 19 North, Range 2 East of the New Mexico Principal Meridian, New Mexico, Geothermal Plat, Status of Public Domain Land and Mineral Titles, Issued by the Bureau of Land Management, State Office, Santa Fe, New Mexico, on April 20, 1981, (hereinafter Township 19 North, Range 2 East, N.M.P.M. Plat).

Township 19 North, Range 3 East of the New Mexico Principal Meridian, Geothermal Plat, Status of Public Domain Land and Mineral Titles, Issued by the Bureau of Land Management, State Office, Santa Fe, New Mexico, on April 20, 1981, (hereinafter Township 19 North, Range 3 East, N.M.P.M. Plat)

22. June 4, 1897, c. 2, § 1, 30 Stat. 35;
 Feb. 1, 1905, c. 288, § 1, 33 Stat. 628;
 Oct. 23, 1962, P.L. 87-869, § 6, 76 Stat. 1157;
 Aug. 31, 1964, P.L. 88-537, 78 Stat. 745;
 Oct. 17, 1968, P.L. 90-578, Title IV, §402, 82 Stat. 1118;
 16 USC 551. This Section was repealed by P.L. 94-579, Title VII, §706(a), Oct. 21, 1976, 90 Stat. 2793, effective on and after Oct. 21, 1976, insofar as applicable to the issuance of rights-of-way over, upon, under, and through the public lands and lands in the National Forest Service but nothing in Section 706(a) may be construed as affecting the authority of the Secretary of Agriculture under the Act of June 4, 1897, 30 Stat. 35, as amended, 16 USC 551, except as it pertains to rights-of-way, P.L. 94-579, §706(b), Oct. 21, 1976) 90 Stat. 2794; 43 USC 1701 note.

23. Minutes of the Mineral Land Classification Board, New Mexico Geothermal Resources Minutes No. 1, March 18, 1971.
24. 36 F.R. 6441 (April 3, 1971)
25. Minutes of Mineral Land Evaluation Board, New Mexico Known Geothermal Resources Area Minutes No. 8, July 14, 1975.
26. 40 F.R. 56699 (Dec. 4, 1975)
27. 32 F.R. 2588 (February 7, 1967)
28. 32 F.R. 4030 (March 14, 1967);
32 F.R. 4506 (March 24, 1967);
32 F.R. 5850 (April 12, 1967);
38 F.R. 35507 (December 28, 1973)
29. 41 F.R. 22964 (June 8, 1976)
30. 32 F.R. 4507 (March 24, 1967)
31. Agreement DOE/FS, p. 4 See text to which footnote 46 is referenced.
32. Agreement DOE/FS, p. 2
33. Agreement DOE/FS, p. 8
34. Letter, dated March 21, 1974, from the Atomic Energy Commission, Area Manager, to the State Director, Bureau of Land Management, Santa Fe, New Mexico.
35. Township 19 North, Range 2 East, N.M.P.M. Plat
36. BLM Manual, Rel. 1-935, 9/18/74, 1275 — Land Status Records, Index of Standard Abbreviations, Appendix 1, pp. 5, 15.
37. Letter, dated June 8, 1978, from the Department of Energy, Area Manager, Los Alamos Area Office to the State Director, Bureau of Land Management.
38. Township 19 North, Range 2 East, N.M.P.M. Plat; Township 19 North, Range 3 East, N.M.P.M. Plat.
39. P.L. 91-581, § 3 (Dec. 24, 1970), 84 Stat. 1566; 30 USC § 1003

40. Drawing No. 81Y210193, dated 2/1/78; attached as Appendix G to Agreement DOE/FS; Letter dated June 8, 1978, from the Department of Energy, Area Manager, Los Alamos Area Office to the State Director, Bureau of Land Management.
41. Application for Geothermal Resources Rejected, March 23, 1981, N.M. 20635, 3210 (943b-7)
42. See 43 CFR 3210.2-4, 3210.3
43. Agreement DOE/FS, p. 9; See also, text to which footnote 46 is referenced.
44. P.L. 91-581, §23(b), (Dec. 24, 1970); 84 Stat. 1573; 30 USC §1022
45. P.L. 95-91, Title VI, Part C, §649, (Aug. 4, 1977), 91 Stat. 600; 42 USC §7259; The utilization of this authority, may, in practice, require the consent of the agency whose facilities or property are to be permitted for use by the Department of Energy.
46. Agreement DOE/FS, p. 9; See also text to which footnotes 31 and 43 are referenced.
47. P.L. 91-581, (Dec. 24, 1970), 84 Stat. 1566, 30 USC §1001-1025
48. 30 CFR Parts 270, 271; 43 CFR Parts 3000, 3200, 3210, 3220, 3230, 3240, 3250. NOTE: Proposed rule making is pending which would revise 43 CFR 3210.2-2, 3211.1, 3211.2 and 3211.3. 44 F.R. 67598 (11/26/79).
49. P.L. 91-581, §4, (Dec. 24, 1970), 84 Stat. 1566, 30 USC §1003
50. 43 CFR 3220
51. 43 CFR 3220.1, 3220.2
52. 43 CFR 3220.3
53. 43 CFR 3220.4
54. 43 CFR 3220.5
55. 43 CFR 3220.6
56. P.L. 91-581 § 4, (Dec. 24, 1970), 84 Stat. 1566, 30 USC §1003

57. 43 CFR 3210
58. 43 CFR 3210.2-1.
59. 43 CFR 3210.4, 3220.6
60. P.L. 91-581, § 3, (Dec. 24, 1970), 84 Stat. 1566, 30 USC §1002
61. P.L. 91-581, § 15(b), (Dec. 24, 1970), 84 Stat. 1571, 30 USC §1014(b)
62. Environment Statement, Geothermal Leasing, Santa Fe National Forest, USDA, Forest Service, Southwestern Region, Albuquerque, New Mexico, 1977.
63. Personal interview with Robert L. Quade, Recreation and Lands Staff Officer, Santa Fe National Forest, and Daniel Winner, District Ranger, Jemez District, Santa Fe National Forest, Santa Fe, New Mexico, July 2, 1981.
64. Environment Statement, Geothermal Leasing, Santa Fe National Forest, USDA, Forest Service, Southwestern Region, Albuquerque, New Mexico, 1977, p. 6, Map of Alternative # 3.
65. Personal interview with Robert L. Quade, Recreation and Lands Staff Officer, Santa Fe National Forest, and Daniel Winner, District Ranger, Jemez District, Santa Fe National Forest, Santa Fe, New Mexico, July 2, 1981.
66. P.L. 91-581, § 6(a) (Dec. 24, 1970), 84 Stat. 1568, 30 USC §1005; 43 CFR 3202.1-2, 43 CFR 3203.1-3
67. P.L. 91-581, § 6(b), (Dec. 24, 1970), 84 Stat. 1568, 30 USC §1005; 43 CFR 3203.1-3
68. P.L. 91-581, § 6(d), (Dec. 24, 1970), 84 Stat. 1568, 30 USC §1005, 43 CFR 3203.1-3
69. P.L. 91-581, § 7, (Dec. 24, 1970), 84 Stat. 1569, 30 USC § 1006, 43 CFR 3203.2, 43 CFR 3201.2
70. P.L. 91-581, §16, (Dec. 24, 1970), 84 Stat. 1571, 30 USC 1015, 43 CFR 3202.1
71. 43 CFR 3202.2-1
72. 43 CFR 3203.4
73. 43 CFR 3205.3-8, 30 CFR 270.17
74. 43 CFR 3205.2
75. P.L. 91-581, §5, (Dec. 24, 1970), 84 Stat. 1567-8, 30 USC §1004.
76. 43 CFR 3205.3-3

- 77. 30 CFR 270.63
- 78. 30 CFR 270.62
- 79. P.L. 91-581, § 8 (Dec. 24, 1970), 84 Stat. 1569, 30 USC §1007, 43 CFR 3205.3-9
- 80. P.L. 91-581, §13, (Dec. 24, 1970), 84 Stat. 1570, 30 USC §1012, 43 CFR 3205.3-7, See also 30 CFR 270.50
- 81. 43 CFR 3205.3-7
- 82. 43 CFR 3205.3-1
- 83. P.L. 91-581, § 8(a), (Dec. 24, 1970), 84 Stat. 1569, 30 USC §1007, 43 CFR 3204.3
- 84. 43 CFR 3206
- 85. 43 CFR 3241
- 86. 43 CFR 3241.2-1
- 87. 43 CFR 3241.2-3
- 88. 43 CFR 3241.2-4
- 89. 43 CFR 3241.2-5
- 90. 43 CFR 3241.1-2(a)
- 91. 43 CFR 3241.1-2(a); 43 CFR 3241.3
- 92. 43 CFR 3241.1-1(c)
- 93. 43 CFR 3241.5
- 94. 43 CFR 3250
- 95. 43 CFR 3250.0-3
- 96. 43 CFR 3250.1-1
- 97. 43 CFR 3250.1-1(a)
- 98. 43 CFR 3250.4-1, 30 CFR 270.71-1(b)

99. 43 CFR 3250.4-2, 30 CFR 270.71-1(a)
100. 30 CFR 270.71-1(c); 43 CFR 3250.1-1
101. 30 CFR 270.2(s); 43 CFR 3250.4-1
102. 43 CFR 3250.4-1
103. 30 CFR 270.2(r); 43 CFR 3250.4-2
104. 30 CFR 270.2(t)
105. 43 CFR 3250 43 CFR 3250.1-1, 43 CFR 3250.4-2
106. 30 CFR 270.71-1(c)
107. 30 CFR 270.71-1(c)
108. 43 CFR 3250.1-1(d)
109. 43 CFR 3250.1-2
110. 43 CFR 3250.3
111. 43 CFR 3250.5-2
112. P.L. 91-581, §15(c), (Dec. 24, 1970), 84 Stat. 1571,
30 USC §1014(c), 43 CFR 3250.5-4
113. 43 CFR 3250.6-2
114. 43 CFR 3250.6-3
115. 43 CFR 3250.7
116. 43 CFR 3250.8
117. 43 CFR 3250.9
118. REA Bulletin 103-2, U.S. Dept., of Agriculture, Dec. 1980
119. Senate Bill 669, 97th Congress, 1st Session, §126
120. Senate Bill 1388, 96th Congress, 1st Session; See Senate
Report on this Legislation, No. 96-699
121. P.L. 91-581, §2(c), (Dec. 24, 1970), 84 Stat. 1566, 30 USC
§1001(c); 43 CFR 3200.0-5
122. Senate Bill 669, 97th Congress, 1st Session

123. 30 CFR 270
124. P.L. 91-581, §14, (Dec. 24, 1970), 84 Stat. 1570, 30 USC §1013, 43 CFR 3200.0-8
125. P.L. 91-581, §8(c), §15(b), (Dec. 24, 1970), 84 Stat. 1569, 1571; 30 USC §1007, §1014; 43 CFR 3201.1-3
126. 43 CFR 3204.1
127. P.L. 91-581, §17 (Dec. 24, 1970), 84 Stat. 1571, 30 USC §1016
128. P.L. 91-581 §27 (Dec. 24, 1970), 84 Stat. 1571, 30 USC §1025
129. P.L. 91-581, §17, §27 (Dec. 24, 1970), 84 Stat. 1571, 30 USC §1016, §1025
130. Memorandum of Understanding for the Geothermal Program, U.S. Geological Survey - Bureau of Land Management - U.S. Fish and Wildlife Service, Cooperative Procedures in the Geothermal Program.
131. This chart was included as Appendix A, to "Geothermal Streamlining Recommendations". A report to the Inter-agency Geothermal Coordinating Council from the Streamlining Task Force on Streamlining the Federal Leasing and Environmental Review Procedures.
132. Cooperative Agreement for the Geothermal Program on National Forest System Lands, U.S. Department of Interior, Geological Survey - U.S. Department of Agriculture, Forest Service.
133. P.L. 91-581, §14 (Dec. 24, 1970), 84 Stat. 1571, 30 USC §1013
134. 43 CFR 3200.0-8
135. P.L. 91-581, §8(c), §15(b), (Dec. 24, 1970), 84 Stat. 1569, 1571; 30 USC §1007, §1014; 43 CFR 3201.1-3
137. Forest Service Manual - 12/79 - §2822.31e; See 43 CFR 3200.0-8
138. Forest Service Manual - 12/79 - §2822.31e
139. 36 CFR Part 251; 45 FR 38327, (June 6, 1980); See 45 FR 43167 (June 26, 1980) for correction of typographical and editorial errors.
140. 36 CFR 251.51(k); 45 FR 38328, (June 6, 1980).

141. 36 CFR 251.54; 45 FR 38328-9, (June 6, 1980)
142. 36 CFR 251.54; 45 FR 38329, (June 6, 1980).
143. 36 CFR 251.54; 45 FR 38329, (June 6, 1980).
144. 36 CFR 251.54; 45 FR 38329, (June 6, 1980).
145. 36 CFR 251.62; 45 FR 38333, (June 6, 1980).
146. 36 CFR 251.54; 45 FR 38330, (June 6, 1980).
147. 36 CFR 251.55; 45 FR 38330, (June 6, 1980).
148. 36 CFR 251.56; 45 FR 38330, (June 6, 1980).
149. 36 CFR 251.56(b); 45 FR 38330-1, (June 6, 1980)
150. 36 CFR 251.64; 45 FR 38333, (June 6, 1980).
151. 36 CFR 251.56(c); 45 FR 38331, (June 6, 1980).
152. 36 CFR 251.56(d); 45 FR 38331, (June 6, 1980).
153. 36 CFR 251.56(e); 45 FR 38331, (June 6, 1980).
154. 36 CFR 251.57; 45 FR 38332, (June 6, 1980).
155. 36 CFR 251.59; 45 FR 38332 (June 6, 1980).
156. 36 CFR 251.59; 45 FR 38333, (June 6, 1980).
157. 36 CFR 251.60(a); 45 FR 38332 (June 6, 1980).
158. 36 CFT 251.60(j); 45 FR 38332, (June 6, 1980).
159. Personal interview with Mr. William Porter Grace, Senior Program Coordinator, Energy Research and Technology Division, Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico, March 16, 1981; Letter, dated March 13, 1981, to J. K. Gaddy, HDR Program, Los Alamos National Laboratory, Los Alamos, New Mexico; Telephonic communication to J. K. Gaddy, HDR Program, Los Alamos, National Laboratory, Los Alamos, New Mexico.
160. Agreement DOE/FS, p. 9

161. Agreement DOE/FS, p. 9
162. Agreement DOE/FS, p. 9
163. Agreement DOE/FS, p. 1, 11
164. Act June 30, 1949, c. 228, 63 Stat. 377; 40 USC §471; See 40 USC §484
165. 41C CFR Part 101
166. 41C CFR Part 109
167. Act. June 30, 1949, c. 228, Title VI [V], §602(c) - (e) [§502(c) - (e)]. 63 Stat. 401; 40 USC 484 (13)
168. 41C CFR Part 101-45.105-3(a). Practice may limit the availability of this exemption to activities related to those previously performed by the Atomic Energy Commission with respect to nuclear weapons and not to the development of non-nuclear energy technologies.
169. P.L. 95-91, Title VI, Part C, §646, (Aug. 4, 1977), 91 Stat. 599, 42 USC 7256(a); See also authority granted in P.L. 95-224, (Feb. 3, 1978), 92 Stat. 3; 41 USC 501, et seq.;
170. P.L. 95-91, Title VI, Part C, §646, (Aug. 4, 1977), 91 Stat. 599, 42 USC 7256(b)
171. P.L. 93-410, Title I, §105, (Sept. 3, 1974), 88 Stat. 1084, 30 USC §1125
172. P.L. 95-91, Title III, §301, (Aug. 4, 1977), 91 Stat. 565, 577; 42 USC §7151
173. P.L. 93-410, Title I, §105, (Sept. 3, 1974), 88 Stat. 1084, 30 USC §1125
174. P.L. 93-410, §3, (Sept. 3, 1974), 88 Stat. 1080, 30 USC §1102; See discussion in Hot Dry Rock Geothermal Resource Ownership and the Law, by J. J. McNamera and E. L. Kaufman, LA-8027-HDR, September, 1979.
175. P.L. 93-577, § 7, (Dec. 31, 1974), 88 Stat. 1883, 42 USC §5906
176. P.L. 93-577, § 8, (Dec. 31, 1974), 88 Stat. 1886, 42 USC §5907
177. P.L. 95-224, (Feb. 3, 1978), 92 Stat. 3; 41 USC §501, et seq.

178. P.L. 95-224 §4, 5, 6, (Feb. 3, 1978); 92 Stat. 4, 5; 41 USC §503, 504, 505
179. P.L. 95-224, §6 (Feb. 3, 1978), 92 Stat. 5; 41 USC §505
180. P.L. 93-410, Title I, §105, (Sept. 3, 1974), 88 Stat. 1084, 30 USC §1125
181. P.L. 93-577, §7, 8, (Dec. 31, 1974); 88 Stat. 1883, 1886; 42 USC §5906, 5907
182. Memorandum, June 12, 1980, to Francis Riche, Chief, Property and Equipment Branch, Procurements and Contracts Management Directorate, from Theodore S. Sasso, Attorney, Office of the Assistant General Counsel for Procurement; Subject: Authority to Vest Title to Personal Property in Cooperative Agreement Partners, (hereinafter - DOE TRANSFER OF TITLE MEMO.)
183. DOE TRANSFER OF TITLE MEMO, p. 4
184. DOE TRANSFER OF TITLE MEMO, p. 3-4, See 41 C CFR 101-43.320
185. 10 CFR 600, Subpart A
186. 10 CFR 600, Subpart C
187. International Energy Agency Implementing Agreement for a Programme of Research, Development and Demonstration on Hot Dry Rock Technology, dated September 19, 1979, for the Kernforschungsanlage Julich GMBH (designated by the Government of Germany and for the Department of Energy for and on behalf of the government of the United States of America (hereinafter Agreement DOE/WG)
188. Personal interview with Mr. William Porter Grace, Senior Program Coordinator, Energy Research and Technology Division, Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico. March 16, 1981.
189. Agreement DOE/WG, Article 4(a)
190. Agreement DOE/WG, Article 4(d)
191. Agreement DOE/WG, Article 2(a)
192. Agreement DOE/WG, Article 2(c)
193. Agreement DOE/WG, Article 2(d)

194. Agreement DOE/WG, Article 2(e)
195. Agreement DOE/WG, Article 9(a)
196. Agreement DOE/WG, Annex C
197. Personal interview with Mr. William Porter Grace, Senior Program Coordinator, Energy Research and Technology Division, Albuquerque Operations Office, U.S. Department of Energy, Albuquerque, New Mexico, March 16, 1981.
198. Agreement DOE/FS, Appendix F, IV
199. Agreement DOE/WG, Annex, B.2

REGULATIONS, PERMITS, AND LAWS

METHODOLOGY

Legal research was performed to identify governmental agencies which have statutory or regulatory authority with respect to geothermal resources, power plant siting, construction and operation, related environmental concerns, and other public protection and welfare responsibilities.

Personal contact, by either telephone or personal conveyance was made with each state and federal agency identified as having such authority. A listing of these contacts is included in the appendices to this study. During each contact, the agency was advised of the purpose of the HDR study and the possibility of the development of the project. In addition, attempts were made to confirm the role of each agency in the proposed commercial demonstration reviewed in this study.

A portion of this section is presented as a chart showing state and federal governmental permitting requirements. This format was selected as an aid to the reader by simplifying the review of the permits, authorizations, approvals, and consultations with which a developer may be required to comply prior to or at certain development stages of the construction and operation of the proposed HDR power plant. See Tables 8 and 9.

Table 8

STATE OF NEW MEXICO PERMITTING REQUIREMENTS

<u>APPROVAL</u>	<u>AGENCY</u>	<u>AUTHORITY</u>
1. Approval, if owner or operator sells electricity to regulated utilities for resale	N.M. Public Service Commission	Section 62-6-4(B), N.M.S.A. 1978
2. Location Permit, if generating plant of 300 MW or greater capacity and for associated transmission lines of 230 KV or greater capacity	N.M. Public Service Commission	Section 62-9-3, N.M.S.A. 1978
3. Certificate of Public Convenience and Necessity, if a public utility not within its service area or if a municipality or Los Alamos County participating in a jointly owned plant	N.M. Public Service Commission	Sections 62-9-1, 62-9-3.1 N.M.S.A. 1978
4. Issuance of Securities by public utility or wholesaler to regulated utilities	N.M. Public Service Commission	Sections 62-6-1 through 62-6-11 N.M.S.A. 1978
5. Permit(s) for use of Public Highway for Location of Facilities	Appropriate County Commission	Section 62-1-3, N.M.S.A. 1978
6. Permit(s) for Highway crossings for transmissions	N.M. State Highway Commission	Sections 67-3-12(c), 67-3-41, 67-8-13, N.M.S.A. 1978 Comp.
7. Building Permits	Commerce and Industry Department, Construction Industries Division	Section 60-13-45, N.M.S.A. 1978
8. License(s) Contractor	Commerce and Industry Department, Construction Industries Division	Sections 60-13-1, <u>et seq.</u> N.M.S.A. 1978
9. Permit, Emission of Air contaminants, in excess of 10 lbs. per hour or 25 tons annually or air pollutant	Department of Health and Environment, Environmental Improvement Division	Section 74-2-7, N.M.S.A., 1978, and Air Quality Control Regulation No. 702

Table 8 (Continued)

<u>APPROVAL</u>	<u>AGENCY</u>	<u>AUTHORITY</u>
10. Registration, emission of more than 2000 lbs annually of air contaminant	Department of Health and Environment Environmental Improvement Agency	Section 74-2-7 N.M.S.A. 1978 and Air Quality Regulation No. 702
11. Notice of Intent to Discharge	Water Quality Control Commission	Section 76-6-5 N.M.S.A. 1978, Water Quality Reg. 1-201
12. Groundwater Discharge plan(s)	Water Quality Control Commission	Sections 74-6-4(I) 74-6-5, N.M.S.A. 1978, and Water Quality Reg., Part 3
13. Plans and Specifications for sewerage systems	Water Quality Control Commission	Section 74-6-5 N.M.S.A. 1978, and Water Quality Regs. 1-202
14. Notification of Discharge of	Water Quality Control Commission	Section 74-6-5, N.M.S.A. 1978, and Water Quality Regs. 1-203
15. Liquid waste disposal system (2000 gallons or less per day)	Department of Health and Environment, Environmental Improvement Division	Section 74-1-7 N.M.S.A., 1978, Liquid Waste Disposal Regs. No. 102
16. Vehicle Oversize and overweight	Motor Transportation Department	Section 66-7-413 N.M.S.A. 1978
17. Solid Waste Management	Department of Health and Environment Environmental Improvement Division	Section 74-1-7, N.M.S.A. 1978 Solid Waste Management Regulations No. 103
18. Permit and License appropriation of surface Water	State Engineer	Sections 72-5-1 <u>et seq.</u> , N.M.S.A. 1978

Table 8 (Continued)

<u>APPROVAL</u>	<u>AGENCY</u>	<u>AUTHORITY</u>
19. Permit, appropriation of ground water	State Engineer	Section 72-12-1, <u>et. seq.</u> , N.M.S.A. 1978
20. Permit, change in use or location of Well	State Engineer	Section 72-12-7, N.M.S.A. 1978
21. Plan of Replacement	State Engineer	Sections 72-12A-4, 72-12A-8, 72-12A-9, N.M.S.A. 1978
22. Ground water well permit in declared basin	State Engineer	Section 72-12-12, N.M.S.A. 1978
23. Geothermal resource development	Oil Conservation Division, Energy and Minerals Dept.	Section 71-5-1 <u>et. seq.</u> , N.M.S.A. 1978

Table 9

FEDERAL GOVERNMENT PERMITTING REQUIREMENTS

<u>APPROVAL</u>	<u>AGENCY</u>	<u>AUTHORITY</u>
1. Prevention of Significant Deterioration of Air Quality Permit	Environmental Protection Agency	42 USC §7475 40 CFR 52.21 See: 40 CFR 52.1635
2. Consultation for Protection of endangered or threatened species or critical habitat	U.S. Fish and Wildlife Service	16 USC §1536 50 CFR, Part 402
3. Underground Injection Control Permit	Environmental Protection Agency	42 USC §300 40 CFR Parts 122, 146
4. National Pollutant Discharge Elimination System	Environmental Protection Agency	33 USC §1251, 40 CFR, Parts 122, 124, 125, 129, 133
5. Permit for treatment, storage or disposal of hazardous waste	Environmental Protection Agency	42 USC §6925 40 CFR 260-266
6. Notice of Obstruction affecting navigable airspace	Federal Aviation Administration	49 USC §§1304, 1348, 1354, 1501, 14 CFR, Part 77
7. Historic and Cultural Preservation	State Historic Preservation Officer, Advisory Council on Historic Preservation	16 USC 470, 4711, 36 CFR, Part 800 E.O. 11593
8. Explosives, Permits	Department of Treasury, Bureau of Alcohol, Tobacco & Firearms	18 USC, Chapter 40 27 CFR, Part 181

LOCAL GOVERNMENT REQUIREMENTS

Counties are authorized to adopt zoning ordinances for all or any portion of the county that is not within the zoning jurisdiction of a municipality.¹ Sandoval County has not to date enacted such an ordinance under this authority.² If, however, the Sandoval County Commission exercises this authority, such an ordinance could have application to the construction of the proposed HDR power plant, particularly as to location and design.

The HDR Project site is not within the boundaries affected by the jurisdictional authority of any New Mexico municipality.

STATE GOVERNMENT REQUIREMENTS

Utility Regulation

The NMPSC, under the Public Utility Act,³ supervises and regulates every public utility in respect to its rates, service regulations, and securities.⁴ The sale, furnishing or delivery of electricity by a person⁵ to a utility for resale is subject to the limited regulation by the NMPSC relative to the reasonableness of cost and the adequacy of delivery methods to the utility.⁶

General Orders and Rules have been issued by the NMPSC concerning specific areas of its regulatory authority as conferred by the Public Utility Act.⁷

An inspection and supervision fee in an amount equal to one-half of one percent of gross receipts derived from business transacted in New Mexico for the preceding calendar year is required to be paid annually by each utility

doing business in New Mexico.⁸ This fee is not charged on gross receipts from a sale of electricity to a utility regulated by the NMPSC for resale to the public.⁹

A listing of the approval and permitting authorities of the NMPSC is included in Table 8.

Acquisition of Water Rights

All water within New Mexico is public water and is subject to appropriation for beneficial use.¹⁰

The State Engineer, who is the director of the Water Resources Division of the Natural Resources Department, has general supervision, including measurement, appropriation, distribution, and apportionment of New Mexico waters.¹²

Surface Water

An application for a permit shall be made to the State Engineer by any person, association or corporation intending to acquire the right to beneficial use of surface waters before any construction is begun.¹³ This application shall include the amount of water sought and the period(s) of annual use as well as other information sufficient to identify the right applied for and to show the feasibility of the construction and the capability of the applicant to complete the construction.¹⁴ A notice of intention to make formal application may be filed prior to the formal application for a permit thereby giving the applicant, upon the timely fulfillment of the information and formal application filings required, a priority of application from the date the notice of intention was filed.¹⁵ Upon the filing of a proper and complete application, the applicant is

directed by the State Engineer, in a form prescribed by him, to publish notice of the application in a newspaper of general circulation for three weeks.¹⁶ Proof of such publication must be filed with the State Engineer.¹⁷ Objections or protests to the granting of the application may be filed within 10 days of the last publication of the notice and must be so stated in the above advertisement.¹⁸ If such an objection or protest is filed on time, a hearing on the application shall be held.¹⁹

The State Engineer may approve an application, which becomes a permit, to appropriate water upon a finding that there is unappropriated water available for the benefit of the applicant. The permit may be for less water or for a period of annual use different than that applied for.²⁰

The time within which any construction must be completed and the water applied to beneficial use is set by the State Engineer within statutory maximum periods.²¹

The State Engineer may reject an application if there is no unappropriated water available or refuse to approve any application or notice of intention to make application if approval of such would be contrary to the public interest.²²

A certificate of construction is issued by the State Engineer when the works is found by him to be satisfactory. This certificate sets out the capacity of the works and may limit the water right if the condition of the works so warrant.²³

A license is issued by the State Engineer, after inspection, to appropriate water for beneficial use as described in the permit. This license is to be granted on or before the date set for the application of the water to beneficial use.²⁴

Ground Water

Any person, firm or corporation desiring to appropriate ground waters²⁵ in declared basins for industrial uses shall make application to the State Engineer.²⁶ This application shall include an identification of the particular underground source from which the water is to be appropriated, the beneficial use to which the water is to be applied, the location of the proposed well, the name of the land owner of the proposed well location, the use for which the water is desired and the amount of water applied for.²⁷ Notice of the application must be published weekly for three weeks. Ten days are allowed after the third publication date to allow for objections.²⁸ If no objections are filed, the State Engineer may grant the application and issue a permit to appropriate all or a portion of the waters applied for, subject to prior appropriations from the source, availability of unappropriated waters, or that impairment of existing water rights will not result.²⁹ If objections have been filed or if the State Engineer is of the opinion that the permit should not be issued, the application may be denied without a hearing. A hearing may, however, be held before the State Engineer acts on the application.³⁰

Licenses issued by the State Engineer are necessary prior to the commencement of any drilling of a well for ground water in a declared basin.³¹

Permits and other documents defining or limiting water rights are to be recorded in the Office of the County Clerk of the county where the works are located.³²

Water rights may also be acquired by assignment³³ or by lease.³⁴ An assignment of a permit or license will not be binding upon anyone, other than the parties thereto, unless filed with the State Engineer.³⁵

An application requesting approval of the use and location thereof must be filed by a lessee of a water right prior to his use of any water leased³⁶. Upon the filing of such an application, notice is published in a newspaper of general circulation for three weeks. A hearing on the application will be held if a protest is filed or upon the request of the applicant if the application is denied or modified by the State Engineer.³⁷ Otherwise, the State Engineer may grant the application without a hearing³⁸ if the proposed use and location of use by the applicant is shown to be a beneficial use and will not impair any existing right in a manner greater than it is or would be impaired by the owner's continued use and location.³⁹

In any instance when the appropriation of water for beneficial use would impair existing water rights, a right of replacement is granted, upon application to and subject to rules and conditions set by the State Engineer.⁴⁰ Statutory standards guide the State Engineer's consideration of submitted plans of replacement.⁴¹ The right of eminent domain is available to acquire right-of-way for works necessary for the replacement of water.⁴² This right is not for the condemnation of water rights,⁴³ however, and is not available for the taking of state, federal, or trust lands.⁴⁴

Regulation of Geothermal Resources

The Geothermal Resources Conservation Act, enacted by the State of New Mexico, directs the Oil Conservation Division (OCD) of the New Mexico Energy and Minerals Department to conserve, to prevent waste, and to protect the correlative rights of all owners of geothermal resources within the State of New Mexico.⁴⁵ Pursuant to its authority,⁴⁶ the OCD has adopted rules and

regulations applicable to geothermal resources in this State.⁴⁷ Noting that the HDR Project reviewed here underlies and is located upon land owned by the federal government, the OCD Rules and Regulations provide that:

It is recognized by the Division that all persons conducting geothermal operations on United States Government land shall comply with the United States Government regulations. Such persons shall also comply with all applicable State rules and regulations which are not in conflict therewith.⁴⁸

Accordingly, the OCD Rules and Regulations must be reviewed by the developer demonstrating the HDR Project's commercial viability in order to determine applicable reporting and operational requirements contained therein. In addition to Sections setting forth Definitions⁴⁹ and Miscellaneous Rules,⁵⁰ the OCD Rules and Regulations generally concern reporting and operational requirements for Drilling and Production,⁵¹ Abandonment, Temporary Abandonment and Plugging of Wells,⁵² Purchase of Geothermal Resources,⁵³ Geothermal Injection and Disposal Wells,⁵⁴ and Blowout Prevention.⁵⁵ Rules of Procedure governing hearings before the OCD are also contained in these rules and regulations,⁵⁶ as is a description of the reports and records required to be retained and filed with the OCD relative to geothermal resources operations.⁵⁷

Environment

The Environmental Improvement Division of the New Mexico Department of Health and Environment is responsible for environmental management in New Mexico,⁵⁸ including implementation and enforcement of the Air Quality Control Act,⁵⁹ as well as regulation of liquid and solid waste disposal.⁶⁰ The Water Quality Control Commission, under its regulations and standards implements and enforces the Water Quality Act.⁶¹ Permitting responsibility under the Water Quality Act is assigned by the Water Quality Control

Commission to one of its constituent agencies.⁶² The permitting requirements of these laws are set out in New Mexico Permitting Requirements, as shown in Table 8.

Environmental regulations, applicable to geothermal exploration, development, and use are surveyed in an Interagency Energy - Environmental Research and Development Report of the Office of Research and Development U.S. Environmental Protection Agency.⁶³

New Mexico Permitting Task Force

By Executive Order, the Governor of New Mexico, on February 20, 1981, created a Permitting Task Force to develop and implement procedures to facilitate the review of energy projects by federal and state agencies.⁶⁴ This task force is directed to develop a coordinated permitting process for the State of New Mexico. The work of this task force may prove helpful to any developer undertaking the commercial demonstration of the hot dry rock resource by simplifying, through coordination, the permitting processes required of such an undertaking.

FEDERAL GOVERNMENT REQUIREMENTS

Regulation of Geothermal Resources

The operation of a federal geothermal resources lease is overseen and supervised by the USGS.⁶⁵ Regulations have been prescribed governing such operation.⁶⁶ Pursuant to the jurisdiction of the Deputy Conservation Manager, formerly the Area Geothermal Supervisor,⁶⁷ Geothermal Resources Operational Orders (GRO Order) have been issued defining and directing the detailed procedures to be followed in each particular area of operations⁶⁸ on a geothermal lease. A GRO Order has been issued to cover each of the following operational aspects of a geothermal lease: Exploratory Operations,⁶⁹ Drilling Completion and Spacing of Geothermal Wells,⁷⁰ Plugging and Abandonment of Wells,⁷¹ General

Environmental Protection Requirements,⁷² Pipelines and Surface Production Facilities,⁷³ Production and Royalty Measurement, Equipment, and Testing Procedures.⁷⁴

In Addition, GRO Order 5, "Plans of Operation, Permits, Reports, Records and Forms" has been issued.⁷⁵ Included within this GRO Order is specific, yet concise direction pertaining to plans, permits, records, and reports necessary for geothermal resources lease operation. Six separate phases are viewed within this GRO Order to provide for the orderly development of geothermal resources.⁷⁶ Each phase is to be covered by a plan,⁷⁷ identified as a Plan of Exploration.⁷⁸ Plan of Baseline Data Collection,⁷⁹ Plan of Development,⁸⁰ Plan of Injection or Disposal,⁸¹ Plan of Utilization,⁸² and Plan of Production.⁸³ Plans must be approved by the Deputy Conservation Manager and the surface management agency, in this instance the Forest Service, before permits authorizing initiation of any activities contained in a Plan will be issued.⁸⁴ Permits issued are Geothermal Exploration Permits,⁸⁵ Geothermal Drilling Permits,⁸⁶ Geothermal Sundry Notices,⁸⁷ and Geothermal Utilization Permits.⁸⁸ In addition, the filing of certain other reports may be required. These reports are: Completion of Exploration Operations,⁸⁹ Geothermal Well Completion Report,⁹⁰ Geothermal Pollution Incident Report,⁹¹ Geothermal Accident and Injury Report,⁹² Monthly Report of Sales and Royalties,⁹³ Annual Report of Expenditures for Diligent Exploration Operations,⁹⁴ Annual Report of Compliance with Environmental Protection Requirements,⁹⁵ Baseline Date Report,⁹⁶ Environmental Quarterly Report,⁹⁷ Monthly Report of Facility Operations,⁹⁸ and Miscellaneous Completion Reports.⁹⁹

Certain records must be maintained at the worksite and made available, upon request, to the Deputy Conservation Manager. These records include Daily Drilling Report and Record,¹⁰⁰ Well Logs and Surveys,¹⁰¹ Servicing Records,¹⁰² Company Records,¹⁰³ and Safety Records.¹⁰⁴

With respect to each plan, permit, record, and report, GRO Order 5 sets out when submittal is required, the requirements for inclusion, the applicable reference to the regulations, and any associated approvals required.

Attached to GRO Order 5 is a flow diagram outlining the applications and regulatory process for the operation of federal geothermal leases.¹⁰⁵ Exhibit 3 to GRO Order 5 sets out, by operational activity on a geothermal lease, the plan in which the activity must be addressed, the permit by which each activity must be authorized, and the representative process time for submittal of a complete plan application.¹⁰⁶ Forms for Geothermal Permits and Reports are included in the appendix to this GRO Order.¹⁰⁷

The USGS operational requirements of the United States Geological Survey are complex and thorough. An attempt to explain these requirements by an abbreviated schedule would be incomplete and, accordingly, misleading. Prior to any activity on a geothermal resources lease, reference should be made to GRO Order 5 to determine compliance and authorization requirements.

Environment

In addition to the federal geothermal lease provisions relative to pollution abatement generally, there are also requirements regarding pesticides and herbicides, water pollution, air pollution, erosion control, noise control, sanitation and waste disposal, land subsidence, seismic activity, aesthetics, fish and wildlife, antiquities, and historical sites specifically.¹⁰⁸ A lessee of a federal geothermal lease must collect

environmental data concerning the leased property for a period of one year prior to the submission of a plan of production.¹⁰⁹ Guidelines for acquiring this required data have been prepared to aid Federal Geothermal Resources lessees.¹¹⁰

An Environmental Analysis of the Fenton Hill site was issued in 1979,¹¹¹ and an Environmental Assessment Report on Revision of the Environmental Analysis was prepared in early 1980.¹¹² Although this environmental data would be available to the developer demonstrating the commercial electrical generation from the resource, there is a question as to whether this data would be sufficient to fulfill the one-year environmental data collection period.

The U.S. Environmental Protection Agency implements and administers federal environmental requirements under the Clean Air Act,¹¹³ the Federal Water Pollution Control Act,¹¹⁴ the Safe Drinking Water Act,¹¹⁵ and the Resource Conservation and Recovery Act.¹¹⁶ The permitting requirements of these laws are set out in the Federal Permitting Requirements, Table 9.

Protection of Endangered Species

The Secretary of the Interior through the U.S. Fish and Wildlife Service is directed by the Endangered Species Act of 1973,¹¹⁷ to determine endangered or threatened species of fish, wildlife or plants;¹¹⁸ and other categories being protected under this Act.¹¹⁹

Any action authorized or funded by a federal agency with respect to the commercial development of the HDR Project may require consultation with the U.S. Fish and Wildlife Service to determine that such action will not jeopardize the continued existence of any endangered or threatened species or the habitats of such species.¹²⁰

Historic and Cultural Preservation

The Advisory Council on Historic Preservation, an independent agency of the United States Government,¹²¹ administers a program whereby Federal plans and programs preserve sites and structures of historical, architectural or archaeological importance.¹²² The State Historic Preservation Officer (SHPO)¹²³ consults with the Council in reviewing any federal, federally assisted or funded undertaking to determine the effect on historic and cultural preservation.¹²⁴

Demonstration Projects

DOE administers the Geothermal Energy Research, Development and Demonstration Act of 1974¹²⁵ and the Non-nuclear Energy Research and Development Act of 1974.¹²⁶ It is the purpose of these acts to accelerate the commercial demonstration of geothermal energy technologies¹²⁷ through federal assistance.¹²⁸ If the federal assistance for the construction of any demonstration project established under these acts exceeds \$10,000,000, specific Congressional authorization is required.¹²⁹ If an initial Congressional authorization for the Federal contribution to a demonstration should subsequently prove insufficient or if such an authorization were subject to annual appropriations, the risk of unavailable funding during the construction or operational stages of the project would have to be addressed.

CONCLUSIONS AND RECOMMENDATIONS

The permitting processes for this project are complex. The most unique permitting requirements for a utility engaged in developing this project will be those administered by the USGS under the GEOTHERMAL ACT governing the operations of geothermal leases.

Nevertheless, the fact HDR Rock resource is undemonstrated in a commercial operation will pose questions of application and interpretation of the applicable statutory and regulatory processes until now unasked.

Inasmuch as the projected beginning date for the development of this commercial project is a number of years away, the permitting processes identified should be monitored for amendments which could affect their possible application to this project. Further, the contacts made at the agencies of the federal, state and local governments identified as having regulatory and permitting authority with respect to this project should be kept apprised of any progress made toward the actual development of this project.

REFERENCES

1. Sections 3-21-1 to 3-21-14 NMSA 1978 Comp.
2. Personal contact, Sandoval County Clerk's Office, March 4, 1981.
3. Section 62-3-1 et seq NMSA 1978 Comp.
4. Section 62-6-4 (A) NMSA 1978 Comp. (1980 Supp.); For definitions of "public utility" or "utility", "securities", "rate", "service" or "service regulation", see Sections 62-3-3 (G), (7), (H) and (T) NMSA 1978 Comp. (1980 supp.) respectively. See also limitations and exceptions to term "public utility" or "utility" set out in Section 62-3-4 NMSA 1978 Comp.
5. The term "person" is defined in Section 62-3-3 (E) NMSA 1978 Comp. (1980 Supp.)
6. Section 62-6-4 (B) NMSA 1978 Comp. (1980 Supp.)
7. Applicable NMPSC General Orders and Rules include:
 - Second Revised General Order Number 1, Appendix A; Rules of Practice and Procedure of the New Mexico Public Service Commission
 - First Revised General Order No. 2: Tariff Schedule Rules
 - General Order Number 5: Regulations Governing Service Supplied by Electric Public Utilities
 - Second Revised Order 10: Rules Relating to Extensions, Improvements and Additions and to Cooperative Agreements between or among Utilities
 - General Order No. 28: Rules Governing Price and Purchased Power Cost Adjustment Clause for Electric Utilities.
 - General Order No. 33: Rules and Regulations Governing Energy Conservation Programs by Electric and Gas Utilities
 - General Order No. 37: Rules and Regulations Governing Cogeneration and Small Power Production

8. Section 62-8-8 NMSA 1978 Comp.
9. Section 62-8-8 NMSA 1978 Comp.
10. Sections 72-1-1, 72-12-1 NMSA 1978 Comp.
11. Section 72-2-1 NMSA 1978 Comp.
12. Section 72-2-9 NMSA 1978 Comp.
13. Section 72-5-1 NMSA 1978 Comp.
14. Section 72-5-1 NMSA 1978 Comp.
15. Section 72-5-1 NMSA 1978 Comp.
16. Section 72-5-4 NMSA 1978 Comp.
17. Section 72-5-4 NMSA 1978 Comp.
18. Section 72-5-5 NMSA 1978 Comp.
19. Section 72-5-5 NMSA 1978 Comp.
20. Section 72-5-6 NMSA 1978 Comp.
21. Section 72-5-6 NMSA 1978 Comp.
22. Section 72-5-7 NMSA 1978 Comp.
23. Section 72-5-10 NMSA 1978 Comp.
24. Section 72-5-13 NMSA 1978 Comp.
25. Section 72-12-1 NMSA 1978 Comp.
26. Section 72-12-3 (A) NMSA 1978 Comp.
27. Section 72-12-3 (A) (1) NMSA 1978 Comp.
28. Section 72-12-3 (D) NMSA 1978 Comp.
29. Section 72-12-3 (E) NMSA 1978 Comp.
30. Section 72-12-3 (F) NMSA 1978 Comp.
31. Section 72-12-12 NMSA 1978 Comp.
32. Section 72-5-21 NMSA 1978 Comp.

33. Section 72-5-22 NMSA 1978 Comp.
34. Water-Use Leasing Act, Sections 72-6-1 to 72-6-7 NMSA 1978
35. Section 72-5-22 NMSA 1978 Comp.
36. Section 72-6-4 NMSA 1978 Comp.
37. Section 72-6-6 NMSA 1978 Comp.
38. Section 72-6-6 NMSA 1978 Comp.
39. Section 72-6-5 NMSA 1978 Comp.
40. Section 72-12A-4 NMSA 1978 Comp. (1980 Supp.)
41. Section 72-12A-8 NMSA 1978 Comp. (1980 Supp.)
42. Section 72-12A-12 NMSA 1978 Comp. (1980 Supp.)
43. Section 72-12A-13 NMSA 1978 Comp. (1980 Supp.)
44. Section 72-12A-12(C) NMSA 1978 Comp. (1980 Supp.)
45. Sections 71-5-1 to 71-5-24 NMSA 1978 Comp.
46. Sections 71-5-8 NMSA 1978 Comp.
47. State of New Mexico Energy and Minerals Department, Oil Conservation Division, Geothermal Resources Section, Rules and Regulations (OCD Rules and Regulations)
48. OCD Rules and Regulations, Section B, Miscellaneous Rules, Rule 6.
49. OCD Rules and Regulations, Section A
50. OCD Rules and Regulations, Section B
51. OCD Rules and Regulations, Section C
52. OCD Rules and Regulations, Section E
53. OCD Rules and Regulations, Section F
54. OCD Rules and Regulations, Section G
55. OCD Rules and Regulations, Section H
56. OCD Rules and Regulations, Section I

57. OCD Rules and Regulations, Section D
58. Section 74-1-7 NMSA 1978 Comp.
59. Sections 74-2-1 to 74-2-17 NMSA 1978 Comp., Ambient Air Quality Standards; Air Quality Control Regulations.
60. Section 74-1-7 NMSA 1978 Comp.
61. Sections 74-6-1 to 74-6-4, 74-6-6 to 74-6-13 NMSA 1978 Comp., Water Quality Control Commission Regulations WQCC 77-1; Water Quality Standards for Interstate and Intrastate Streams in New Mexico.
62. Sections 74-6-2(J), 74-6-4(E), N.M.S.A. 1978 Comp. See minutes of New Mexico Water Quality Control Commission, May 12, 1981.
63. "Survey of Environmental Regulations Applying to Geothermal Exploration, Development and Use," Interagency Energy-Environmental Research and Development Report of the Office of Research and Development U.S. Environmental Protection Agency.
64. Executive Order No. 81-8, February 20, 1981, Bruce King, Governor of the State of New Mexico.
65. 30 CFR 270.10, 270.11, 270.2(c)
66. 30 CFR Parts 270, 271
67. 30 CFR 270.2(c), 45 F.R. 41411 (June 19, 1980)
68. 30 CFR Part 270.11 and 12
69. Geothermal Resources Operation Order 1, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.
70. Geothermal Resources Operation Order 2, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.
71. Geothermal Resources Operation Order 3, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.
72. Geothermal Resources Operation Order 4, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.
73. Geothermal Resources Operation Order 6, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.
74. Geothermal Resources Operation Order 7, USDOI, USGS, Office of the Deputy Conservation Manager, Geothermal.

75. Geothermal Resources Operation Order 5, USDOl, USGS, Office of the Deputy Conservation Manager, Geothermal. This GRO Order is effective in draft form.
76. GRO Order 5, p. 3
77. GRO Order 5, p. 3
78. GRO Order 5, pp. 4-5
79. GRO Order 5, pp. 5-6
80. GRO Order 5, pp. 6-8
81. GRO Order 5, pp. 8-11
82. GRO Order 5, pp. 11-14
83. GRO Order 5, pp. 14-16
84. GRO Order 5, p. 3
85. GRO Order 5, pp. 16-18
86. GRO Order 5, pp. 18-21
87. GRO Order 5, pp. 21-23
88. GRO Order 5, pp. 23-25
89. GRO Order 5, pp. 25-26
90. GRO Order 5, pp. 26-27
91. GRO Order 5, pp. 27-28
92. GRO Order 5, pp. 28-29
93. GRO Order 5, pp. 29-30
94. GRO Order 5, pp. 30-31
95. GRO Order 5, pp. 31-32
96. GRO Order 5, pp. 32-33
97. GRO Order 5, pp. 33-34
98. GRO Order 5, pp. 34

99. GRO Order 5, pp. 34-35
100. GRO Order 5, pp. 35-36
101. GRO Order 5, pp. 36-37
102. GRO Order 5, p. 37
103. GRO Order 5, p. 37
104. GRO Order 5, p. 37
105. GRO Order 5, Flow Diagram Showing Required Applications and Regulatory Process for Development on Federal Geothermal Leases.
106. GRO Order 5, Exhibit 3. Applications and Representative Processing Times for Various Geothermal Activities.
107. GRO Order 5, Appendix
108. 43 CFR 3204.1
109. 30 CFR 270.34 (K)
110. "Guidelines for Acquiring Environmental Baseline Data on Federal Geothermal Leases", United States Department of the Interior, January, 1977
111. Environmental Analysis of the Fenton Hill Hot Dry Rock Geothermal Test Site, Los Alamos Scientific Laboratory, University of California, LA-7830-HDR, Issued: May, 1979
112. Revision to Appendix H, Environmental Analysis of The Fenton Hill HDR Geothermal Test Site, March, 1980
113. 42 USC 7401 et. seq.
114. 33 USC 1251 et. seq.
115. 42 USC 300
116. 42 USC 6901 et. seq.
117. 16 USC 1531 et. seq., as amended
118. Definitions of "species", "endangered species", and "threatened species" are set out in 16 USC 1532 (16), (6), (20), respectively
119. 16 USC 1531, 1533 (d)

- 120. 16 USC 1536, 50 CFR, Part 402
- 121. 16 USC 4701
- 122. 16 USC 470, E.O. 11593 (May 13, 1971) 36 CFR 800
- 123. 36 CFR 800.2 (M)
- 124. 36 CFR 800.4, 800.5
- 125. P.L. 93-410, Title I, §105, (Sept. 3, 1974), 88 Stat. 1084; P.L. 95-238, Title V, §504, (Feb. 25, 1978, 92 Stat. 86; 30 USC §1125; P.L. 95-91, Title III, §301, (Aug. 4, 1977), 91 Stat. 565, 577; 42 USC §7151
- 126. P.L. 93-577, (Dec. 31, 1974), 88 Stat. 1879; 42 USC 5901, et seq; P.L. 95-91, Title III, §301, (Aug. 4, 1977), 91 Stat. 565, 577; 42 USC §7151
- 127. P.L. 93-410, Title I, §105, (Sept. 3, 1974); 88 Stat. 1084; P.L. 95-238, Title V, §504, (Feb. 25, 1978); 92 Stat. 86; 30 USC §1125; P.L. 93-577, §6, (Dec. 31, 1974), 88 Stat. 1881; 42 USC 5905
- 128. P.L. 93-410, Title I. §105, (Sept. 3, 1974); 88 Stat. 1084; P.L. 95-238, Title V, §504, (Feb. 25, 1978); 92 Stat. 86; 30 USC §1125, P.L. 93-577, §7, (Dec. 31, 1974); 88 Stat. 1883; 42 USC 5906
- 129. P.L. 93-410, Title I, §105, (Sept. 3, 1974); 88 Stat. 1084; P.L. 95-238, Title V, §504, 92 Stat. 86, 30 USC §1126. Under the Non-nuclear Energy Research and Development Act of 1974, specific Congressional authorization is required if the federal contribution exceeds \$50,000,000. P.L. 93-577, §8 (Dec. 31, 1974), 88 Stat. 1886; 42 USC §5907

FINANCIAL CONSIDERATIONS

METHODOLOGY

The purpose of this section is to determine if financing would be available should HDR become a viable endeavor. Since Plains is responsible for developing this report, the analysis of financing is limited to the traditional funding sources for rural electric cooperatives.

Plains historically has received its long term funding through low-cost insured REA loans, and the projects which previously have been financed have generally been based on straight-forward proven technology. In recent years, due to the large amounts of cooperative construction expansion, the majority of the generation and transmission funding has shifted to guaranteed REA loans, currently in coordination with the Federal Financing Bank (FFB).

Recent efforts to trim the federal budget threatened to remove the FFB as a Rural Electric funding source. This action could have been a very critical turning point in the future financing of the Cooperative. However, without discussing all the controversy surrounding the issue, the basic assumption must now be made that Plains will remain a prime borrower of REA through the FFB-REA guaranteed loan program.

Potential Sources

The following is a limited summary of potential sources of funding:

(a) REA. REA was formed in May, 1935 with the express purpose of bringing electric power to rural areas. On August 7, 1935, the President issued a regulation establishing REA as a lending agency. Since the time

that Plains was formed in 1952, it has executed loan agreements totalling more than \$368 million, divided between \$44 million in insured loans and \$324 million in guaranteed loans through FFB.

(b) CFC. The National Rural Utility Cooperative Finance Corporation (CFC) was formed in 1969 under the District of Columbia Cooperative Association Act, "to provide, secure, and arrange financing for its members and patrons as required by them for the planning, initiation, and execution of their programs, projects, and undertakings conducted in accordance with, and in pursuance of their objectives". Plains is a Class B member of CFC and to date has invested \$955,969 in Capital Term Certificates and is utilizing a \$50,000,000 line of credit on a floating rate basis.

(c) WBC. The Wichita Bank for Cooperatives (WBC) was organized under the Farm Credit Act of 1933, operates under the supervision of the Farm Credit Administration, and makes and services loans to eligible cooperative associations within its Farm Credit district. Sixty percent of a borrower's patrons must be farmers or rural related, and Plains believes that it can now become a member of WBC under present guidelines.

(d) DOE. DOE can provide funding either under the Federal Grant and Cooperative Agreement Act of 1977 or by guaranteeing loans through the Geothermal Loan Guarantee Program established December 18, 1979. Plains has utilized the Federal Grant and Cooperative Agreement Act of 1977 by receiving a grant for \$121,800 to conduct this study.

Analysis by Source

(a) REA. Alternate energy projects are currently being coordinated through the Energy Management and Utilization Division of REA. However, front-end financing utilizing 5 percent insured loans is no longer available.

It is currently REA's position to continue its commitment to alternate energy development and HDR energy production is included in this category, but long term loans would likely be under the guaranteed load program. Any loan application would be treated like a normal power supply loan request. The key determining factors would be adequate documented justification and satisfaction of NEPA requirements. The loan application would be limited to only the HDR Project covering the generating facility and the related transmission costs.

(b) CFC. The aim of CFC, regarding their loan policy, is "to utilize its financial resources to supplement for the greatest possible number of its members the basic financing of their programs supplied by REA." Loans bear interest at rates determined by CFC on the basis of its cost of money from time to time from both internal and outside sources and on the basis of CFC's operating and reserve needs.

Plains has historically utilized CFC as a supplemental source to REA for short term financing. Plains' lines of credit with CFC provide the necessary funding until REA longer-term fixed-rate financing is arranged. Plains has also used CFC's services in connection with pollution control revenue bonds. CFC has indicated that it will consider advancing debt capital on a long-term basis for such a project as HDR.

(c) WBC. The Banks for Cooperatives will consider project financing on an ad hoc basis. Long term financing requires a lien accommodation with the REA-CFC common mortgage. Also, WBC uses a variable cost of money interest rate which creates uncertainties in long term planning and rate setting.

(d) DOE. The Geothermal Loan Guarantee Program was designed to (1) minimize a lender's financial risk; (2) encourage the flow of credit for geothermal energy projects without the need for federal assistance, and (3) enhance competition and encourage new entrants into the geothermal market. In complying with the objectives of the program, the Secretary of DOE will give first priority consideration to those applications for projects having a plan of operations which shows substantial promise of the prompt development and utilization of energy from undeveloped geothermal resource areas.

Present application requirements are equal to or exceed the requirements of REA. DOE collects a guaranty fee of not more than one percent of the outstanding balance on an annual adjusted basis which REA does not do. DOE would also take action necessary to perfect and maintain liens on assets which are collateral for the guaranteed portion of the loan and a lien accommodation with REA-CFC would be required.

(e) Leveraged Leasing. A less conventional but potentially viable source of financing is leveraged leasing. Leveraged leasing is a form of tax leasing that involves three parties: a lessee which uses the equipment, a lessor that owns the equipment and a bank that provides financing. The basic concept involved is the use by the lessor of the lessee's depreciation and/or investment tax credits which allows for lower financing costs to the lessee. Congressional action is pending on some revised legislation which, if enacted, should facilitate leveraged leasing by electric cooperatives. Again, REA-CFC approval would be required to initiate this type of financing. Potential sources for funding include REA, CFC, WBC and numerous other lending institutions that normally participate in this type of arrangement.

CONCLUSIONS AND RECOMMENDATION

Each of the listed funding sources are potential lenders for the HDR Project. If interest rates are expected to decline on the long term, then it would be considered prudent to choose one of the variable rate sources, namely CFC or WBC, if either offers financing for such a project. If interest rates appear to be holding steady or increasing in the long term, then it would seem likely that REA's or DOE's guaranteed loan packages be chosen.

Based upon the constantly fluctuating market over the past two years, Plains should utilize the REA loan guarantee program through FFB or such other lending source as REA may obtain. Financing through FFB retains a great deal of flexibility in the first seven years of the guarantee and the 34 year term closely corresponds to the estimated life of the reservoir.